INSTRUCTION MANUAL

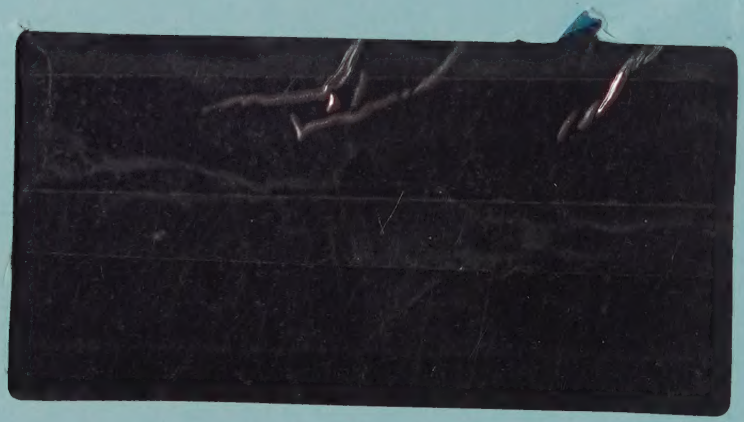
REGULATED POWER SUPPLIES

MODEL
LF-9-04
This manual applies to units
bearing serial no. prefixes B&C.

MP MASTER
MA28355

LAMBDA

LAMBDA ELECTRONICS MELVILLE, L. I., N. Y.



INSTRUCTION MANUAL
FOR
DIGITALLY PROGRAMMED POWER SUPPLY

MODEL
LF-9-04
This manual applies to units
bearing serial no. prefixes B&C.

his manual provides instructions intended for the operation of Lambda power supplies, and is not to be
eproduced without the written consent of Lambda Electronics. All information contained herein applies
o model LF-9-04 unless otherwise specified.

AMBDA ELECTRONICS MELVILLE, L.I., N.Y.
MAIN PLANT TELEPHONE: 516 MYrtle 4-4200

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SPECIFICATIONS AND FEATURES

NOTE: All ratings specified for ASCII are applicable to units with "GPIB" option.

DC OUTPUT — Voltage and current regulated for line and load.

Voltage ranges

X1 range (BCD and ASCII)	0 to (+) or (—) 9.99 volts in 10 mv steps.
X5 range (BCD only)	0 to (+) or (—) 49.95 volts in 50 mv steps.
X10 range (ASCII only)	0 to (+) or (—) 49.9 volts in 100 mv steps.

Current range — Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range. Current limit crossover point may be programmed in 20 ma (1%) steps. The power supply may be used as current source of sink.

AMBIENT TEMPERATURE	MAXIMUM CURRENT (AMPS)
40°C	1.98
50°C	1.80
60°C	1.60

REGULATED VOLTAGE OUTPUT

Regulation, line	0.01% with input variations from 105-132 or 132 to 105 volts AC.
Regulation, load	0.01% with load variations from no load to full load.

Ripple and Noise

X1 range (BCD and ASCII)	2.0 mv peak-to-peak
X5 range (BCD only)	10.0 mv peak-to-peak
X10 range (ASCII only)	20.0 mv peak-to-peak

Temperature Coefficient

X1 range (BCD and ASCII)	Change in output voltage (0.005% + 35 μv)/°C max.
X5 range (BCD only)	Change in output voltage (0.005% + 115 μv)/°C max.
X10 range (ASCII only)	Change in output voltage (0.005% + 215 μv)/°C max.
Remote Sensing	Provision is made for remote sensing to eliminate the effect of power output lead resistance on DC regulation.

REGULATED CURRENT SOURCE

Reulation, line	1.0 ma with input variations from 105-132 or 132 to 105 volts AC.
Regulation, load	20 ma with load variations from 0 to 49.95 volts output.
Temperature Coefficient	Change in current 500μa/°C max.

ZERO OVERRIDE — Safety feature allows emergency programming of power supply output to zero volts. Output will remain at 0 volts ±50 millivolts and ripple will be 15 millivolts peak-to-peak maximum. Low signal input ($0.0V \leqslant V_{IN} \leqslant 0.8V$) must be maintained for normal power supply operation. High signal input ($2.0 \leqslant V_{IN} \leqslant 5.0V$) activates the zero override feature. Zero override is automatically activated when data plug is disconnected. For units with "GPIB" option, consult factory for use of INTERFACE CLEAR command to program zero override. Disconnecting GPIB Data connector does not activate zero override.

CURRENT LIMIT OVERRIDE — Allows one bit current programming for approximately 110% of maximum rated current (1.98A) when using 8, 12, or 24 bit BCD system. When current limit override is programmed (logic "1"), no other current programming is required. Current limit override does not apply for ASCII system or for "GPIB" option.

REMOTE PROGRAMMING - DIGITAL

Input Data Word (Not applicable for "GPIB" option) ..... 24 bit data word*.

*24 bit data word can be accepted in segmented parallel format of 8, 12, or 24 bits BCD or ASCII.

Input Data Word ("GPIB" option) ..... Data is entered in a bit-parallel, byte serial format as specified by IEEE Standard no. 488-1975, LF-9-04-GPIB power supplies are factory wired for ASCII programming. Consult factory for conversion to 8 bit BCD format.

Data Flag (Not applicable for "GPIB" option) ... 3.3 microsecond minimum pulse required at least 2 microseconds after data is presented. Data flag must cease before next data byte is presented.

Data Validity (Not applicable for "GPIB" option)..... 10 microseconds.

Final Transfer pulse (Not applicable for "GPIB" option)..... 2 microsecond minimum pulse. See OPERATING INSTRUCTIONS for timing of pulse. The final transfer pulse is generated internally when using the ASCII system.

Logic Levels**..... Low: $0.0V \leqslant V_{IN} \leqslant 0.8V$.
High: $2.0V \leqslant V_{IN} \leqslant 5.0V$.

**Power supply is factory wired for positive logic input, but can readily be rewired for negative logic. See OPERATING INSTRUCTIONS for input data logic polarity wiring. Units with "GPIB" option are factory wired for negative logic input as specified by IEEE Standard no. 488-1975 and cannot be converted.

Data line loading ..... One CMOS load per line. Compatible with TTL and DTL. For units with "GPIB" option, Data line loading is as specified by IEEE Standard no. 488-1975.

Data line interface (For units with "GPIB" option, Data line interface is as specified by IEEE Standard no. 488-1975.)

CMOS	Direct
DTL	Direct
TTL	Direct, with a 10,000 ohm pull up resistor on each data line to +5 volt buss (5 volt buss not supplied).

Control line loading (For units with "GPIB" option, Control line loading is as specified by IEEE Standard no. 488-1975.)

Final transfer	CMOS input.
Data Flag	CMOS input.
Zero override	15 ma sinking required, compatible with DTL or TTL buffers. Signal is activated when data plug is disconnected.

Address ("GPIB" option only)	Selectable by switch on rear of chassis. Switch no. 1 is least significant digit (DIO-1). "ON" position of switch corresponds to logic "1".
Mode bit ("GPIB" option only)	Power supply mode of operation can be set during any programming sequence on DIO lines 1-8. Program ASCII character "V" for constant voltage operation. Program ASCII character "I" for constant current operation. See "Data Input Connections" for programming directions.
Remote Enable ("GPIB" option only)	Not an applicable function for Lambda model LF-9-04-GPIB. Terminated in logic "0".

Resolution

Voltage	
X1 range (BCD and ASCII)	10 mv min.
X5 range (BCD only)	50 mv min.
X10 range (ASCII only)	100 mv min.
Current	20 ma min.

Accuracy (at 25°C ambient with 115 VAC input, no load)

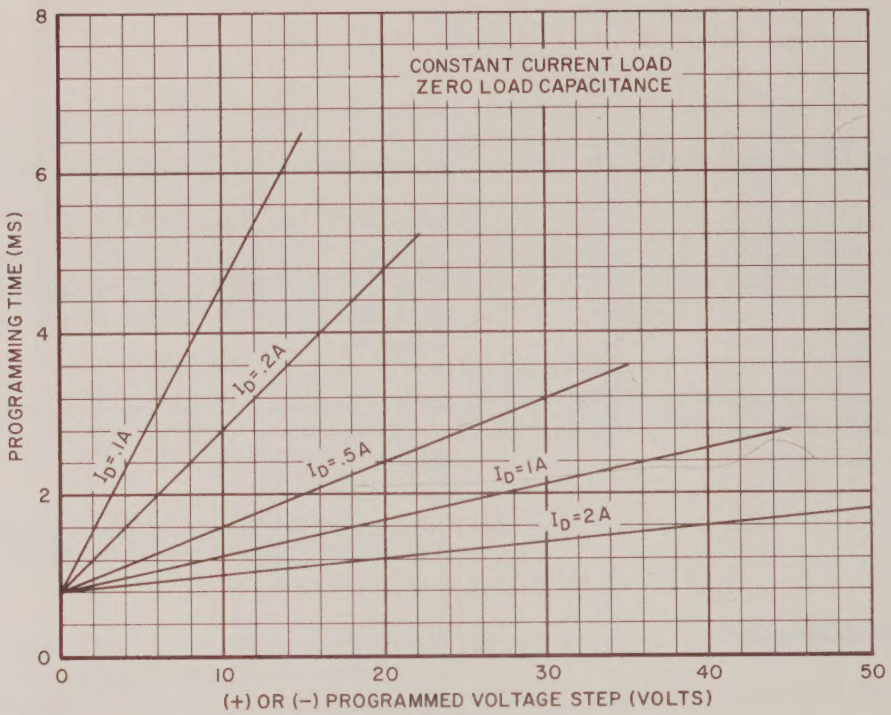
Voltage	
X1 range (BCD and ASCII)	3 mv max. deviation
X5 range (BCD only)	15 mv max. deviation
X10 range (ASCII only)	30 mv max. deviation
Current	10 ma max. deviation

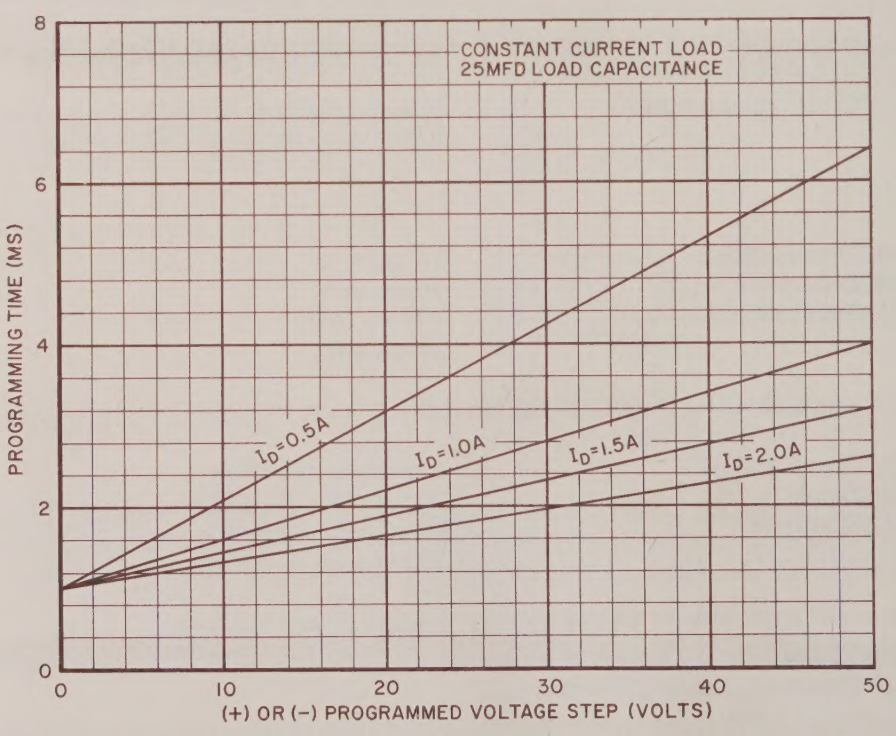
Programming time (not applicable to output polarity changes or gain changes.)

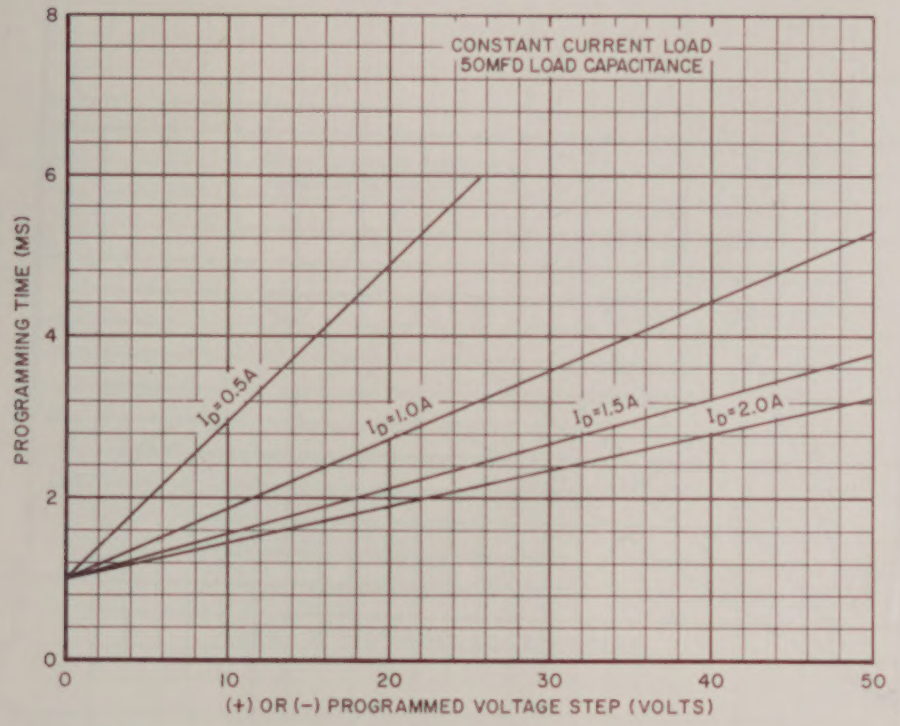
Constant Current Loads

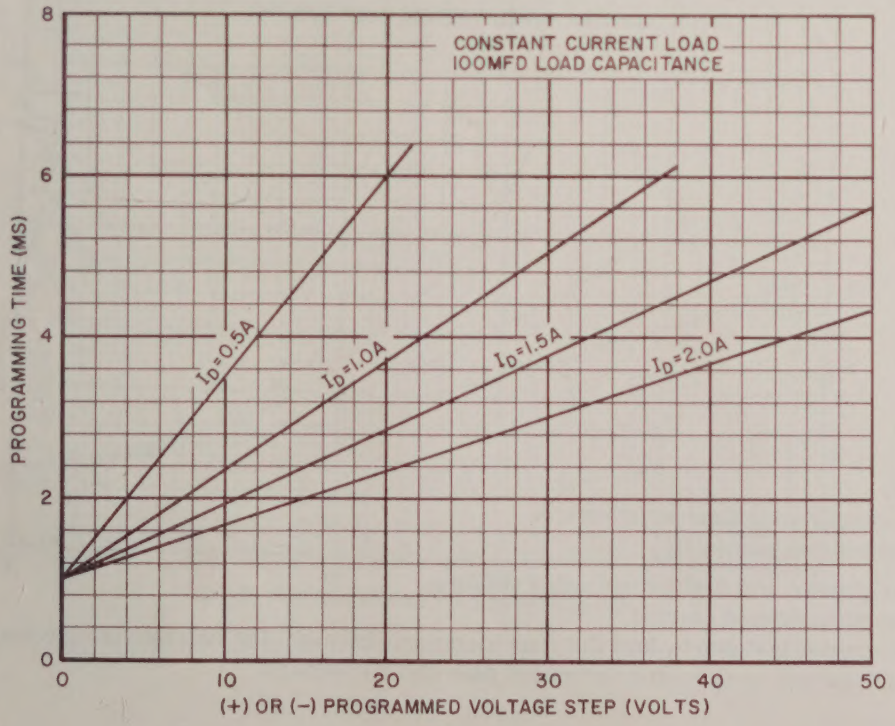
Determine programming time as follows:

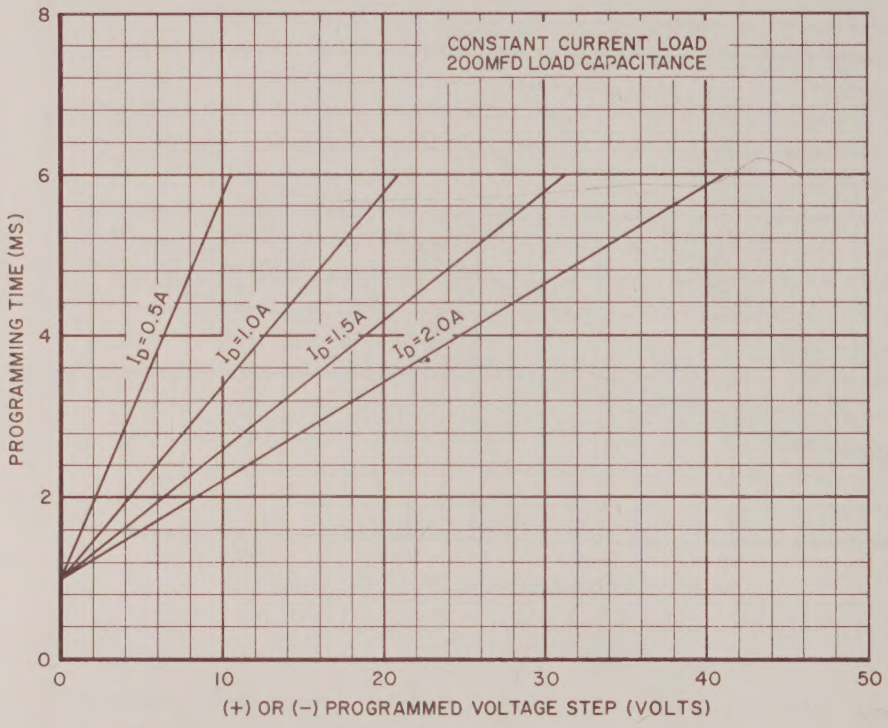
1. Determine current difference I_D by subtracting load current from programmed current.
2. Determine programmed voltage step desired.
3. Determine load capacitance.
4. Find programming time on the appropriate graph.


CONSTANT CURRENT LOAD
ZERO LOAD CAPACITANCE
PROGRAMMING TIME (MS)
0
2
4
6
8
I_D=.1A
I_D=.2A
I_D=.5A
I_D=1A
I_D=2A
0
10
20
30
40
50
(+) OR (−) PROGRAMMED VOLTAGE STEP (VOLTS)


CONSTANT CURRENT LOAD
25MFD LOAD CAPACITANCE
PROGRAMMING TIME (MS)
0
2
4
6
8
I_D=0.5A
I_D=1.0A
I_D=1.5A
I_D=2.0A
0
10
20
30
40
50
(+) OR (−) PROGRAMMED VOLTAGE STEP (VOLTS)


CONSTANT CURRENT LOAD
50MFD LOAD CAPACITANCE
PROGRAMMING TIME (MS)
(+) OR (−) PROGRAMMED VOLTAGE STEP (VOLTS)
I_D=0.5A
I_D=1.0A
I_D=1.5A
I_D=2.0A
0
2
4
6
8
0
10
20
30
40
50

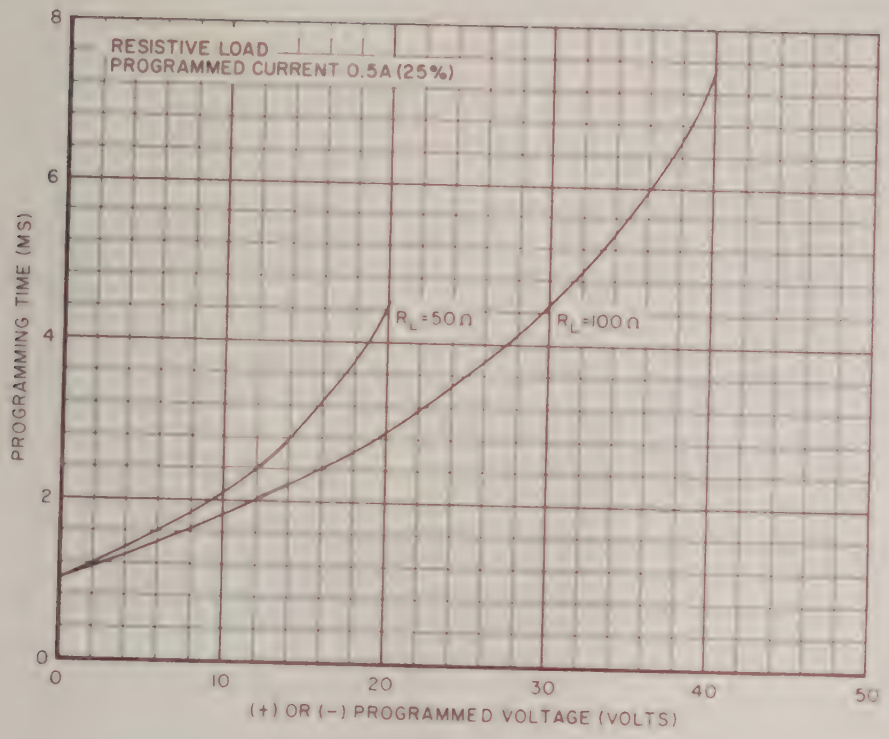

CONSTANT CURRENT LOAD
100MFD LOAD CAPACITANCE
PROGRAMMING TIME (MS)
(+) OR (−) PROGRAMMED VOLTAGE STEP (VOLTS)
I_D=0.5A
I_D=1.0A
I_D=1.5A
I_D=2.0A
0
2
4
6
8
0
10
20
30
40
50

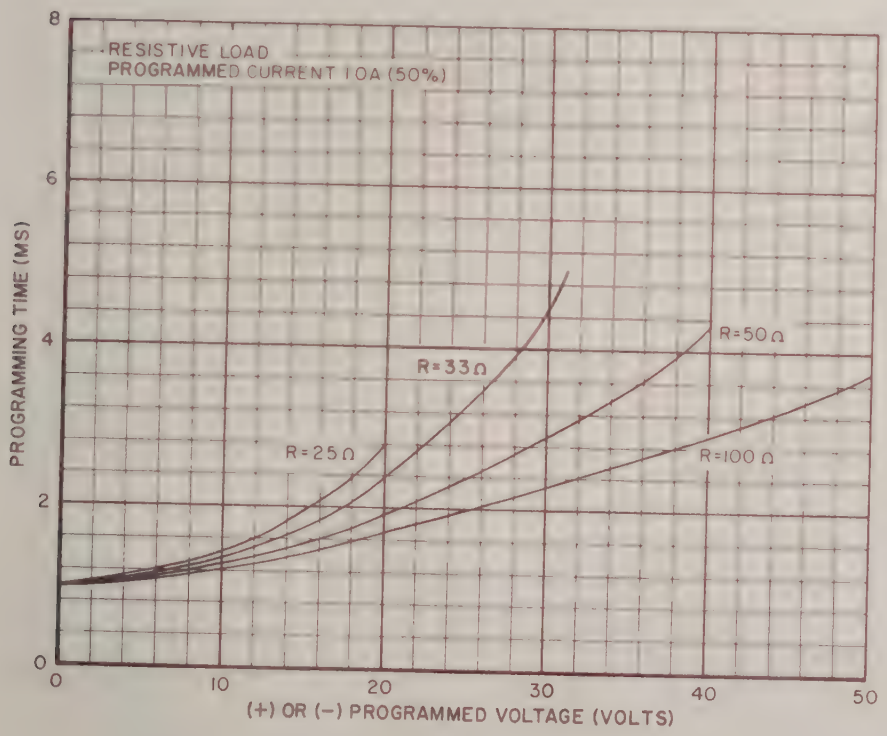


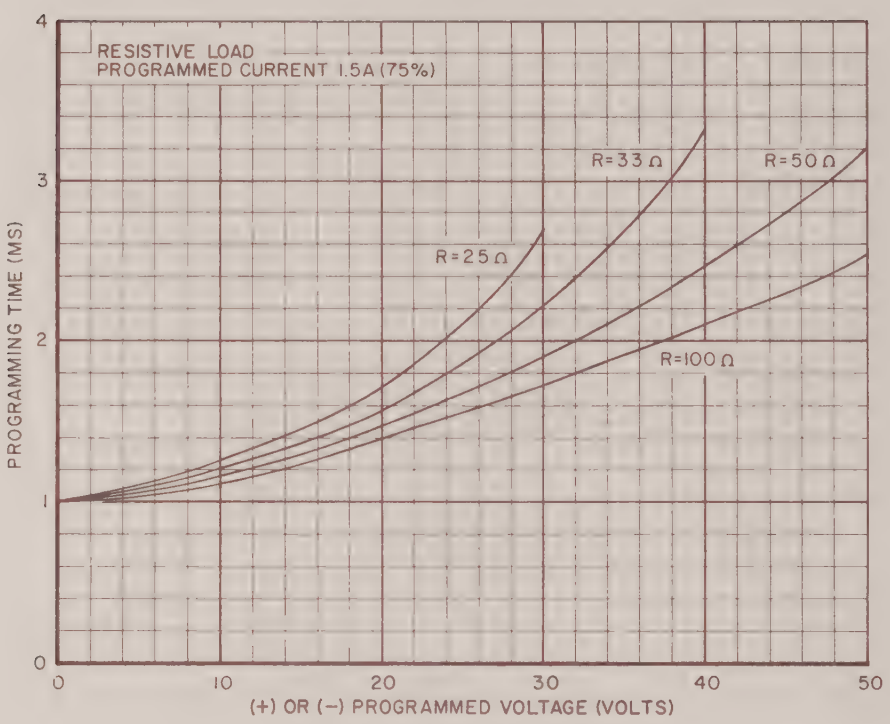
Resistive Loads

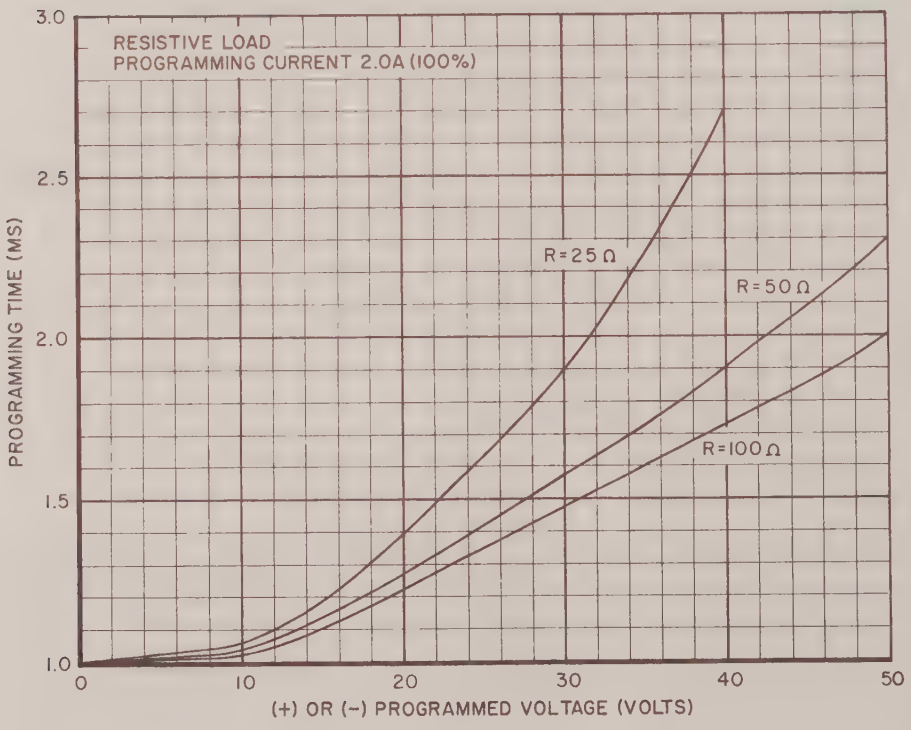
Determine programming time as follows:

1. Determine load resistance R_L
2. Determine present and desired operating voltages.
3. Determine programmed current.
4. Using the appropriate graph, find the time increment between the two operating voltages. Programming time will be this time increment plus one millisecond.


RESISTIVE LOAD
PROGRAMMED CURRENT 0.5A (25%)
R_L=50Ω
R_L=100Ω
PROGRAMMING TIME (MS)
0
2
4
6
8
0
10
20
30
40
50
(+) OR (−) PROGRAMMED VOLTAGE (VOLTS)


RESISTIVE LOAD
PROGRAMMED CURRENT 10A (50%)
R=50Ω
R=33Ω
R=25Ω
R=100Ω
PROGRAMMING TIME (MS)
0
2
4
6
8
0
10
20
30
40
50
(+) OR (−) PROGRAMMED VOLTAGE (VOLTS)


RESISTIVE LOAD
PROGRAMMED CURRENT 1.5A (75%)
R=33 Ω
R=50 Ω
R=25 Ω
R=100 Ω
PROGRAMMING TIME (MS)
0
1
2
3
4
0
10
20
30
40
50
(+) OR (−) PROGRAMMED VOLTAGE (VOLTS)


RESISTIVE LOAD
PROGRAMMING CURRENT 2.0A (100%)
R=25 Ω
R=50 Ω
R=100 Ω
PROGRAMMING TIME (MS)
1.0
1.5
2.0
2.5
3.0
0
10
20
30
40
50
(+) OR (−) PROGRAMMED VOLTAGE (VOLTS)

Output Flags

Current limit flag (Not applicable for "GPIB" option)	Optical coupler, conducting when supply is in current limit mode. Maximum current capability is 1.25 mA.
Busy Ready flag (Not applicable for "GPIB" option)	NPN open collector, logic zero when ready to accept new data. Maximum current capability is 15 mA.
Service request ("GPIB" option only)	Indicates current limit condition when power supply is used as a constant voltage source. Indicates voltage limit condition when power supply is used as a constant current source. Source mode is determined by mode bit.

TRANSIENT RESPONSE — Output voltage will be within 25 mv of programmed voltage within 1.2 milliseconds following a 90% change of load.

OVERSHOOT — 1 volt max for all conditions of turn-on, turn-off, power failure, programming change, or crossover to voltage or current mode.

AC INPUT — 105-132 volts AC at 47-440 Hz. Input power 195 Watts.*
Input current 1.4 Amps*
*With output loaded to full current rating and input voltage 132 volts AC, 60 Hz.

OVERLOAD PROTECTION

Thermal	Thermostat resets automatically when overtemperature condition is eliminated.
Electrical	Programmable, automatic, electronic current-limiting circuit limits output current to preset limit for protection of load and power supply when external overloads and direct shorts occur.

INPUT AND OUTPUT CONNECTIONS

AC input and DC output	Terminal block on rear of chassis.
Data input (Not applicable for "GPIB" option)	44 pin printed circuit board. Mating connector (Elco no. 00-6007-044-980-002) and hood (Amp no. 530087-4) are supplied. Refer to figure 8 for assembly of hood to connector.
Data input ("GPIB" option)	24 pin connector as specified by IEEE Standard no. 488-1975. Pre-assembled molded cables with stackable connectors and thumbscrews (Amphenol part no. 408-30111-302) are commercially available.

OPERATING AMBIENT TEMPERATURE RANGE AND DUTY CYCLE — Continuous duty from 0° C to 60° C ambient. See paragraph on DC OUTPUT for current derating above 40° C ambient.

STORAGE TEMPERATURE (non-operating) — -40° C to 85° C

PHYSICAL DATA

Size (Not applicable for "GPIB" option)	4-15/16" x 7-1/2" x 14"
Size ("GPIB" option)	4-15/16" x 7-1/2" x 14-5/8"
Weight	20 lbs. net.; 22 lbs. shipping
Finish	Gray, FED. STD. 595 No. 26081

MOUNTING — One surface, with tapped mounting holes, can be utilized for mounting this unit. The LF-9-04 power supply must be mounted with top facing up and in a horizontal plane. Refer to figure 12 for mounting details.

MODEL OPTIONS

"V" Option	Standard LF-9-04 power supplies can be obtained for 205-265 VAC, 47-440 Hz input or for 187-242 VAC, 47-440 Hz input. See nameplate for AC input rating.
"GPIB" Option	Standard LF-9-04 power supplies can be obtained for use in a General Purpose Interface Bus (GPIB) system as specified by IEEE Standard no. 488-1975.

ACCESSORIES

Rack Adapters	Rack adapters LRA-10, LRA-11, and LRA-13, used for ruggedized mounting with or without chassis slides are available.
Overvoltage Protectors	Externally mounted adjustable Overvoltage protector LHOV-6 is available.

DEFINITION OF TERMS

DATA FLAG — Customer generated pulse to signal that data is available and ready for processing.

DATA VALIDITY — Minimum time for which data must remain present after data flag is presented.

FINAL TRANSFER PULSE — Customer generated pulse to transfer data from input shift register into storage and the DAC's. The final transfer pulse is generated internally by the power supply when the ASCII system is used.

RESOLUTION — Minimum programable change.

ACCURACY — Maximum deviation from programmed value.

PROGRAMMING TIME — Time, after data entry, required for the supply to reach programmed value, within 0.05%.

OUTPUT FLAGS — Signal generated by power supply, available to user through the input data connector.

OVERSHOOT — Magnitude of voltage by which the output may exceed programmed value or fall below zero volts for all conditions of turn-on, turn-off, power failure, programming change, or crossover to voltage or current mode.

THEORY OF OPERATION

GENERAL

Lambda model LF-9-04 is an analog power supply programmed by a digital control circuit. The control circuit section consists of an intermediate storage register, shift register, a set of storage latches, an auxiliary control circuit, and two DACs (digital-to-analog converters).

The circuit arrangement is shown in block diagram form in figure 9. The circuitry is discussed with reference to the block diagram.

FUNCTIONAL DESCRIPTION

Digital Control Circuit

The 24 bit data word is entered into the intermediate storage registers in a bit parallel, byte serial format. The data entry is controlled by one data flag for each byte or character. The data flag, acting as a timing pulse for the registers, shifts the data serially through the optical couplers and into the shift registers. The optical couplers provide isolation between input and output. After all 24 bits have been entered into the shift register, the final transfer pulse is entered. The leading edge strobes the data into the storage latches. The trailing edge strobes the data into the digital to analog converters and auxiliary control circuit. The DACs generate the analog reference signal that programs the voltage and current operational amplifiers in the analog section. The auxiliary control circuit monitors the plus and minus 15 volt supply voltages and shuts down the analog drive signal in the event of a low voltage condition or when a zero override signal is programmed. The auxiliary control circuit also serves to delay DAC operation during a gain or polarity change in order to allow the relays time to stabilize.

Analog Power Supply Constant Voltage Operation

The power supply output voltage is compared to the DAC output signal by the voltage error amplifier. A change in either signal will produce an error signal at the output of the operational amplifier. If the programming signal from the DAC decreases, the output of the operational amplifier decreases and drive to the series pass transistors is reduced. This action increases the voltage across the series regulator thus reducing the output voltage.

Analog Power Supply Constant Current Operation

The voltage developed across the current sense resistor is compared to the current DAC output signal by the current error amplifier. As load current tends to increase exceeding the programmed value, the current amplifier turns on and decreases the drive signal to the voltage amplifier. This causes the voltage amplifier output to decrease, thereby decreasing the drive to the series pass transistors. This action increases the impedance of the series regulator thus limiting the output current to the programmed value.

Analog Power Supply Constant Voltage Current Sinking Operation

If a voltage in excess of the programmed value is applied to the power supply output, the supply will sink up to rated current in order to maintain output voltage at programmed value.

GPIB Option

Programming data is entered in bit-parallel, byte-serial format. The input sequence consists of the power supply listen address followed by 8 ASCII characters. These characters contain the voltage, current, polarity, gain, and mode information. Data transfer is effected through the 3 wire "handshake" as

specified by IEEE Standard no. 488-1975. The power supply listen address and mode character are processed only by the GPIB decoder. The DAV (data valid) signal generates the data flag for the voltage, current, polarity, and gain characters allowing this data to enter the intermediate storage registers in the same manner as the standard LF-9-04 power supply.

The mode character determines the fault mode for the SRQ (service request) circuit. This programming does not affect the automatic crossover between constant voltage and constant current operation. The mode register output is combined with the current limit flag via an exclusive OR gate. SRQ is then defined as a condition when the power supply mode of operation does not match the programmed mode. SRQ is cleared via the serial poll sequence as specified by IEEE Standard no. 488-1975 and will return a logic "1" on DIO-7. The SRQ signal is gated through the busy/ready flag to prevent false triggering during programming.

The IFC (interface clear) function sets all interface functions (talk, listen, serial poll, etc.) in the idle (inactive) state. This signal can be used to activate the power supply zero override circuit shuting down the power supply output. Consult the factory for this application.

GENERAL DESCRIPTION OF IEEE STANDARD NO. 488-1975

The IEEE Standard no. 488-1975, or general purpose interface bus (GPIB), describes a system for interconnection of one "controller" and up to fourteen pieces of equipment on a single 24 wire bus. Each circuit on the bus is assigned an address, thereby allowing independent or concurrent programming of all units. The interface utilizes a three wire "handshake" scheme to transfer programming data and commands along the bus. This process requires that all addressed units respond to a given command or data byte before the next byte can be generated. In this manner, the system allows the transfer of data to proceed at the rate of the "slowest" addressed unit, thus minimizing data loss.

The bus consists of sixteen data/command lines and eight ground lines. The data/command lines are categorized as follows:

Eight bidirectional signal lines (DIO-1 through DIO-8) carry all addresses, programming data, and multiline commands.

Three "handshake" lines effect the transfer of data bytes along the bus. These lines are:

1. DAV (DATA VALID) — Indicates data on DIO signal lines is valid.
2. NRFD (NOT READY FOR DATA) — Indicates readiness of the unit for data processing.
3. NDAC (NOT DATA ACCEPTED) — Indicates data on DIO signal lines has been accepted, latched into the "listener", and can now be removed.

Five control lines maintain an orderly flow of data across the interface. These lines are:

1. ATN (ATTENTION) — Indicates mode of information on DIO signal lines.
   True (low) indicates information on DIO lines is an address or a command.
   False (high) indicates information of DIO lines is programming data.
2. IFC (INTERFACE CLEAR) — Sets the interface at a known quiescent state.
3. REN (REMOTE ENABLE) — Selects either remote or local control of each device.
4. SRQ (SERVICE REQUEST) — Indicates to the controller that a condition exists within a unit that may require attention or service.
5. EOI (END OR IDENTIFY) — Indicates the end of a particular multiple byte transfer sequence.

There are three types of instruments connected on the bus:

LISTENER — receives and processes programming data.
TALKER — sends programming data.
CONTROLLER — correlates the operation of the instruments on the bus and controls data transfer along the bus.

At any specific point in time any instrument can be either a listener or a talker. Only one controller can be active at one time.

FUNCTIONAL DESCRIPTION OF IEEE STANDARD NO. 488-1975

The programming procedure outlined below is intended to describe the method used to program the Lambda LF-9-04-GPIB power supply. The general concepts discussion, however, are equally applicable to any instrument on the bus.

The units address is contained on lines DIO-1 through DIO-5. Any combination of digits except 11111 can be used. The LF-9-04-GPIB address is chosen by setting the address switch on the rear of the supply. Each switch corresponds to a DIO signal line. Switch no. 1 is least significant digit (DIO-1). ON position of the switch corresponds to logic "1" (low). If switches no. 1 and 2 are placed in the ON position and switches 3, 4, and 5 are placed in the OFF position, the LF-9-04-GPIB address would be 00011. The listen address would then be given as X0100011. The first three bits (X01) represent the listen command. The last five bits (00011) represent the power supply's address.

The following sequence is used to program the LF-9-04-GPIB power supply:

1. The controller sets the ATN line low (true) indicating that the information on the DIO signal lines is to be interpreted as a command.
2. The controller puts the power supply address and listen command on the DIO signal lines.
3. The power supply responds by setting NRFD high (false) and NDAC low (true) indicating it is ready for data.
4. The controller sets DAV low (true) indicating that the information on the DIO signal lines is valid.
5. Once the power supply has latched the information, it sets NRFD low (true) and NDAC high (false) indicating that the data has been accepted.
6. The controller sets DAV high (false) indicating that the data on the DIO signal lines is no longer valid.
7. The controller now places the next byte of information on the DIO signal lines and once again waits for the power supply to set NRFD high and NDAC low.

After the listen command is accepted, the ATN line is reset to high indicating that the information on the DIO signal lines is programming data. The controller now enters the programming data bytes following the preceeding sequence. The last byte is transfered along the EOI indicating the end of that set of instructions.

During programming, the mode bit is set for either constant voltage or constant current operation. In the event of crossover to the incorrect mode of operation, the power supply will set the SRQ line low indicating a fault condition. The controller resolves the service request as follows:

1. The controller sets the ATN line low (true) indicating commands on the signal lines.
2. The controller clears the interface of all previous talkers and listeners by using the universal commands UNT and UNL.

3. The controller sends the serial poll enable (SPE) command placing the interface in the serial poll mode.
4. The controller sends the power supply talk address.
5. The power supply responds by setting the SRQ line high (false) indicating that it was the originator of the service request. The power supply is now in the talker state while the controller is in the listener state.
6. The controller sets NRFD high (false) and NDAC low (true) indicating that it is waiting for data.
7. The power supply sets DIO-7 and EOI low followed by DAV low.
8. The controller sets NRFD low (true) and NDAC high (false) indicating that it has accepted the data.
9. The power supply sets DAV high (false).
10. The controller sets ATN low (true).
11. The controller now sends serial poll disable (SPD) command releasing the interface from the serial poll mode.
12. The controller sets ATN high (false) concluding the serial poll sequence. All additional data is now transmitted as previously outlined.

OPERATING INSTRUCTIONS

BASIC MODES OF OPERATION

This power supply is designed to operate as a positive or negative constant voltage or constant current source.

Constant Voltage. The power supply will function as a constant voltage source while load current is less than the current value I_{LIM} programmed. When $V_P/R_L = I_{LIM}$ (V_P = programmed voltage, R_L = load resistance), the supply will cross over automatically and will operate as a constant current source. Further decrease in value of R_L results in a decrease of voltage across the load while current remains regulated to I_{LIM}.

Constant Current (Automatic Crossover). The power supply will function as a constant current source while the load voltage V_L is less than the value programmed. When load voltage V_L equals the value programmed, the supply will automatically cross over and operate as a constant voltage source.

CONNECTIONS FOR OPERATION

NOTE: Make all connections to the unit before applying input power.

CAUTION: AC input power must be applied to the unit prior to applying data input signal.

Ground Connections. The Lambda power supply can be operated either with negative or positive output terminal grounded. Both positive and negative ground connections are shown in the diagrams for all suggested output connections illustrated in this manual.

AC Input and DC Output Connections. Make all AC input and DC output connections to the supply at the terminal block on the rear of the supply. Apply input power to terminals 1 and 2; always connect the ungrounded (hot) lead to terminal 1.

The V1 terminal is brought out to terminal 8. The V2 terminal is brought out to terminal 6. When the supply is programmed for positive voltage output, V1 (terminal 8) is positive and V2 (terminal 6) is negative. When the supply is programmed for negative voltage output, V2 (terminal 6) is positive and V1 (terminal 8) is negative. Recommended wiring of the power supply to the load and selection of wiring is shown in figures 1 through 4. Selection of proper wiring is made on the basis of load requirements. Make all performance checks and measurements of current or voltage at the rear output terminals. Connect measuring devices directly to terminals or use the shortest leads possible.
The optional overvoltage protector is always connected to terminals 3 and 4. The positive (red) lead is connected to terminal 4 (+OV) and the negative (black) lead is connected to terminal 3(−OV). Proper overvoltage protector connection is shown in figures 3 and 4.

Data Input Connections (Not applicable for "GPIB" option). All programming connections are made at the 44 pin printed circuit board connector on the rear of the supply. The power supply is shipped from the factory with a shunt board covering the printed circuit board connections. This shunt board must be removed before the mating connector can be connected. Whenever the mating connector is disconnected the shunt board should be reconnected. Data input connector pin functions and proper data input connector wiring is shown in figures 5 and 6. Assembly of the mating connector hood is shown in figure 8.

Data Input Connections ("GPIB" option). All programming connections are made at the 24 pin GPIB connector on the rear of the supply. Data input connector pin functions and proper data input connector wiring is as specified by IEEE Standard no. 488-1975 and is shown in figure 7.

SUPPLY LOAD CONNECTIONS

The output impedance and regulation of the power supply may change when using the supply as a constant voltage source and connecting leads of practical length are used. To minimize the effect of the output leads on these characteristics, remote sensing is used. Recommended supply-load connection with local or remote sensing are described in the following paragraphs.

Refer to figure 1 to determine voltage drop for particular cable length, wire size, and current conditions. Lead lengths must be measured from supply terminals to load terminals as shown in figure 2.

Local Sensing Connection, Figure 3. Local sensing is the connection suitable for applications with relatively constant load or for applications with short power output leads.

Remote Sensing Connection, Figure 4. Remote Sensing provides compensation for the DC voltage drops in the connecting cables. Sensing leads should be a twisted pair to minimize AC pick-up. A 2.5 mf, nonpolar, capacitor may be required between output terminals and sense terminals to reduce noise pick-up.

DATA INPUT CONNECTIONS (Not applicable for "GPIB" option)

The power supply voltage and current output is adjusted by means of digital programming. The unit will accept a 24 bit data word from CMOS, DTL, and TTL logic with a logic level of 0 to +5 volts.* The data word can be accepted in a segmented parallel format of 8 bits BCD, 12 bits BCD, 24 bits BCD, or ASCII. See section on SPECIFICATIONS AND FEATURES for specific programming data requirements. Proper data input connections are described in the following paragraphs and shown in figures 5 and 6.

*The power supply is factory wired for positive logic input, but can readily be rewired for negative logic. See paragraph on DATA INPUT LOGIC POLARITY.

8 Bit BCD System, Figure 5. The eight bit BCD system programs the power supply in three bytes of eight bits each. Data connections are made to data inputs one through eight. Input data is transmitted as follows:

First byte

Data 1—8	
Data 2—4	Most significant digit
Data 3—2	BCD Voltage programming
Data 4—1	
Data 5—8	
Data 6—4	Second digit
Data 7—2	BCD Voltage programming
Data 8—1	

Second byte

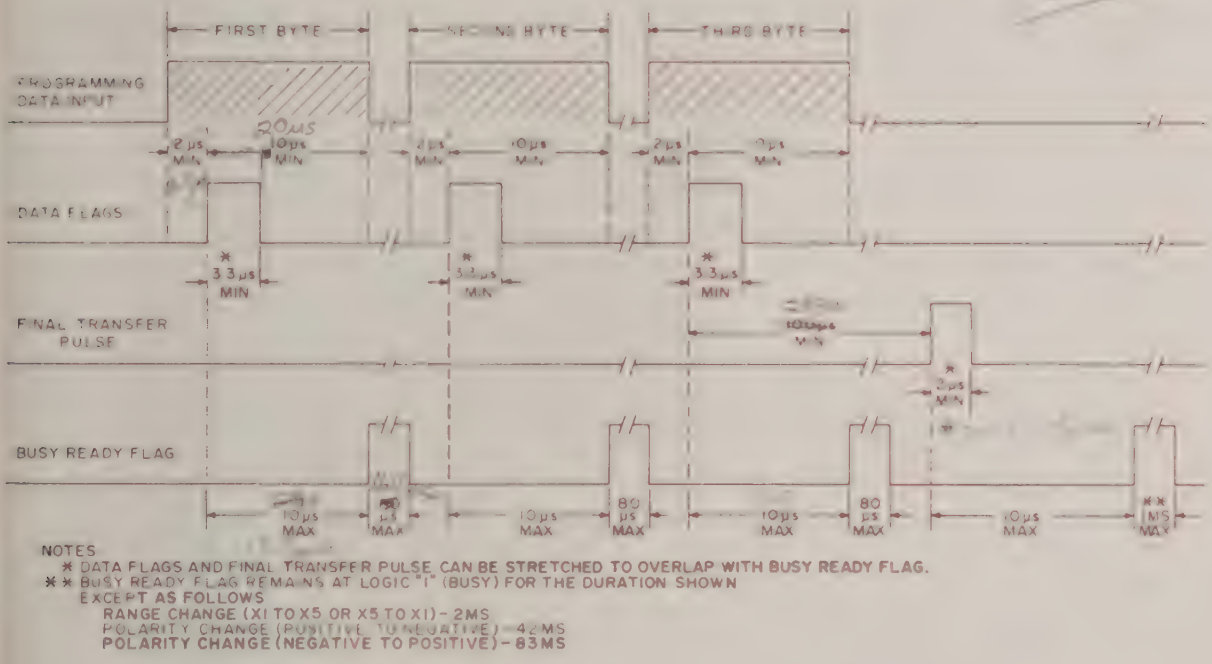
Data 1—8	
Data 2—4	Third Digit
Data 3—2	BCD Voltage programming
Data 4—1	

Data 5—Not Used
Data 6—Gain - logic "0" for X1 range, logic "1" for X5 range.
Data 7 —Polarity - logic "0" for positive, logic "1" for negative.
Data 8—Current limit override - logic "1" for override

Third byte

Data 1—8	
Data 2—4	Most Significant digit
Data 3—2	BCD Current Programming
Data 4—1	
Data 5—8	
Data 6—4	Second Digit
Data 7—2	BCD Current Programming
Data 8—1	

Each byte must be followed by a Data Flag pulse. Allow 100 microseconds minimum between the third Data Flag and the Final Transfer pulse. Refer to timing diagram below.



NOTES
* DATA FLAGS AND FINAL TRANSFER PULSE CAN BE STRETCHED TO OVERLAP WITH BUSY READY FLAG.
** BUSY READY FLAG REMAINS AT LOGIC "1" (BUSY) FOR THE DURATION SHOWN
EXCEPT AS FOLLOWS
RANGE CHANGE (X1 TO X5 OR X5 TO X1) - 2MS
POLARITY CHANGE (PUNITIVE TO NEGATIVE) - 42MS
POLARITY CHANGE (NEGATIVE TO POSITIVE) - 83MS

Allow 5 milliseconds minimum between successive range changes. Allow 200 milliseconds minimum between successive polarity changes.

12 Bit BCD System, Figure 5. The twelve bit BCD system programs the power supply in two bytes of twelve bits each. Data connections are made to data inputs one through twelve. Input data is transmitted as follows:

First byte

Data 1—8	
Data 2—4	Most significant digit
Data 3—2	BCD Voltage programming
Data 4—1	
Data 5—8	
Data 6—4	Second digit
Data 7—2	BCD Voltage programming
Data 8—1	
Data 9—8	
Data 10—4	Third digit
Data 11—2	BCD Voltage programming
Data 12—1	

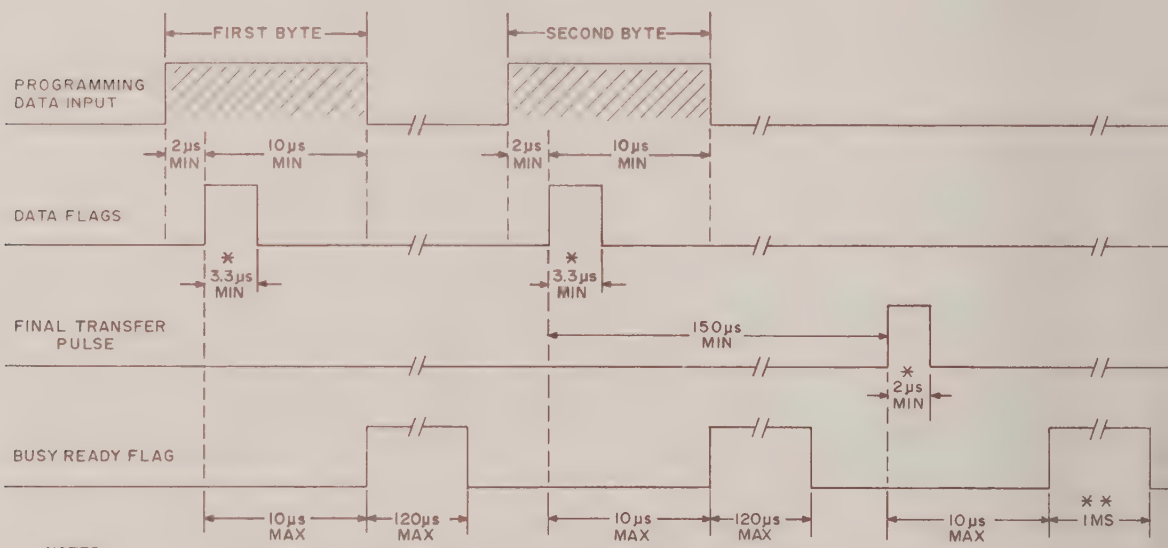
Second byte

Data 1—Not Used
Data 2—Gain - logic "0" for X1 range, logic "1" for X5 range.
Data 3—Polarity - logic "0" for positive, logic "1" for negative.
Data 4—Current limit override - logic "1" for override

Data 5—8
Data 6—4
Data 7—2
Data 8—1
} Most significant digit BCD current programming

Data 9—8
Data 10—4
Data 11—2
Data 12—1
} Second digit BCD current programming

Each byte must be followed by a Data Flag pulse. Allow 150 microseconds minimum between second Data Flag and the Final Transfer pulse. Refer to timing diagram below.



NOTES
* DATA FLAGS AND FINAL TRANSFER PULSE CAN BE STRETCHED TO OVERLAP WITH BUSY READY FLAG.
** BUSY READY FLAG REMAINS AT LOGIC "1" (BUSY) FOR THE DURATION SHOWN
EXCEPT AS FOLLOWS:
RANGE CHANGE (X1 TO X5 OR X5 TO X1) - 2MS
POLARITY CHANGE (POSITIVE TO NEGATIVE) - 42MS
POLARITY CHANGE (NEGATIVE TO POSITIVE) - 83MS

Allow 5 milliseconds minimum between successive range changes. Allow 200 milliseconds minimum between successive polarity changes.

24 Bit BCD System, Figure 5. The twenty four bit BCD system programs the power supply in one byte of twenty four bits. Data connections are made to data inputs one through twenty four. Input data is transmitted as follows:

Data 1—8
Data 2—4
Data 3—2
Data 4—1
} Most significant digit. BCD voltage programming

Data 5—8
Data 6—4
Data 7—2
Data 8—1
} Second digit BCD voltage programming

Data 9—8
Data 10—4
Data 11—2
Data 12—1
} Third digit BCD voltage programming

Data 13—Not used

Data 14—Gain - logic "0" for X1 range, logic "1" for X5 range.

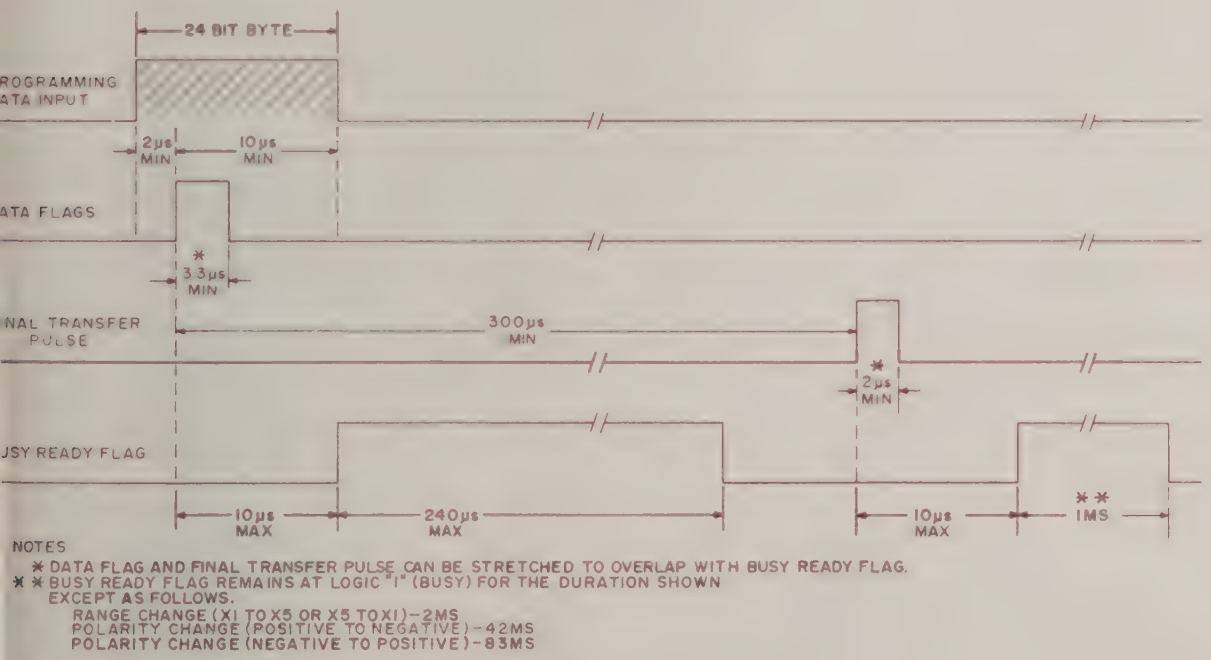
Data 15—Polarity - logic "0" for positive, logic "1" for negative.

Data 16—Current limit override - logic "1" for override.

Data 17—8
Data 18—4
Data 19—2
Data 20—1
} Most significant digit BCD current programming

Data 21—8
Data 22—4
Data 23—2
Data 24—1
} Second digit BCD current programming

ıe byte must be followed by a Data Flag pulse. Allow 300 microseconds minimum between the Data ag and the Final Transfer pulse. Refer to timing diagram below.



NOTES
* DATA FLAG AND FINAL TRANSFER PULSE CAN BE STRETCHED TO OVERLAP WITH BUSY READY FLAG.
** BUSY READY FLAG REMAINS AT LOGIC "1" (BUSY) FOR THE DURATION SHOWN EXCEPT AS FOLLOWS.
RANGE CHANGE (X1 TO X5 OR X5 TO X1) - 2MS
POLARITY CHANGE (POSITIVE TO NEGATIVE) - 42MS
POLARITY CHANGE (NEGATIVE TO POSITIVE) - 83MS

Allow 5 milliseconds minimum between successive range changes. Allow 200 milliseconds minimum between successive polarity changes.

ASCII System, Figure 6. Each ASCII character consists of eight bits: four identification bits and four information bits. Transmission of the complete ASCII word requires seven bytes (characters) of eight bits each. Data connections are made to data inputs one through eight. Input data is transmitted as follows:

Typical byte (character)

Data 1—MSB	Identification Bits
Data 2	
Data 3	
Data 4	
Data 5	Information bits
Data 6	
Data 7	
Data 8—LSB	

The seven ASCII characters are transmitted as follows:

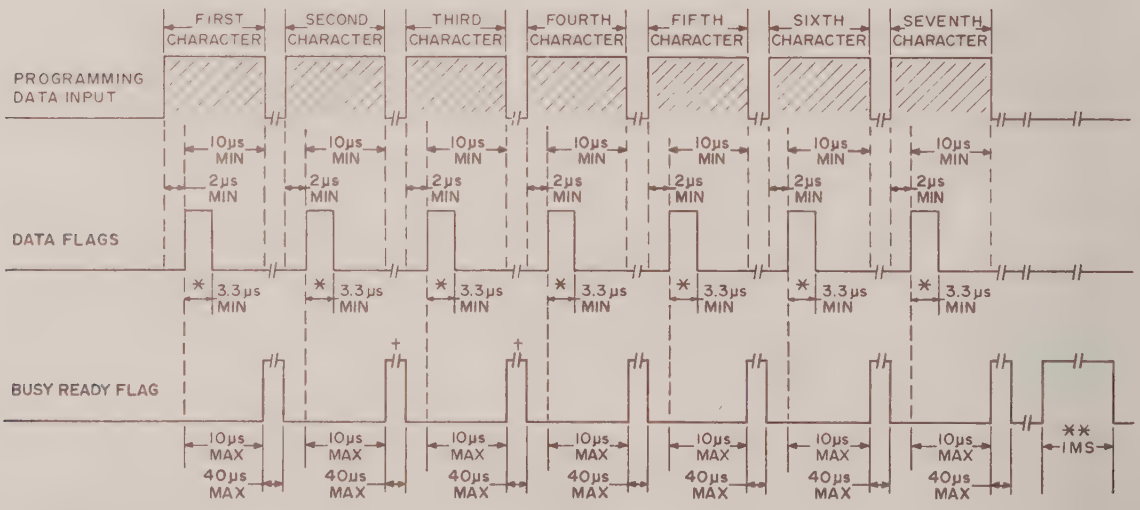
For output voltages up to 9.99 volts (X1 range):

First Character	Voltage - Most significant digit
Second Character	Decimal point
Third Character	Voltage - Second digit
Fourth Character	Voltage - Third digit
Fifth Character	Polarity
Sixth Character	Current - Most significant digit
Seventh Character	Current - Second digit.

For voltage up to 49.9 volts (X10 range):

First Character	Voltage - Most significant digit
Second Character	Voltage - Second Digit
Third Character	Decimal point
Fourth Character	Voltage - Third digit
Fifth Character	Polarity
Sixth Character	Current - Most significant digit
Seventh Character	Current - Second digit

Each character must be followed by a Data Flag pulse. The Final Transfer pulse is generated automatica by the power supply following the seventh character. Refer to timing diagram below.



NOTES

* DATA FLAGS CAN BE STRETCHED TO OVERLAP WITH BUSY READY FLAG.

** BUSY READY FLAG REMAINS AT LOGIC "1" (BUSY) FOR THE DURATION SHOWN EXCEPT AS FOLLOWS:
- DECIMAL POINT LOCATION CHANGE–2MS
- POLARITY CHANGE (POSITIVE TO NEGATIVE)–42 MS
- POLARITY CHANGE (NEGATIVE TO POSITIVE)–83 MS

+ DECIMAL POINT (SECOND OR THIRD CHARACTER DEPENDING ON VOLTAGE RANGE USED) WILL NOT GENERATE A BUSY READY FLAG.

Allow 5 milliseconds minimum between successive decimal point location changes. Allow 200 milliseconds minimum between successive polarity changes.

DATA INPUT CONNECTIONS ("GPIB" option)

The power supply voltage and current output is adjusted by means of digital programming. The unit will accept an 8 bit data word as specified by IEEE Standard no. 488-1975. The power supply is factory wired to accept the data word in ASCII format. Consult factory for conversion to accept a segmented parallel format of 8 bit BCD. Proper data input connections are specified by IEEE Standard 488-1975, described below, and shown in figure 7.

Each ASCII character consists of eight bits: four identification bits and four information bits. Transmission of the complete ASCII word requires eight bytes (characters) of eight bits each. Data connections are made to data inputs DIO-1 through DIO-8. Input data is transmitted as follows:

Typical byte (character)

DIO—1—MSB	Identification Bits
DIO—2	
DIO—3	
DIO—4	
DIO—5	Information Bits
DIO—6	
DIO—7	
DIO—8—LSB	

The eight ASCII characters are transmitted as follows:

For output voltages up to 9.99 volts (X1 range):

First Character	Voltage - Most significant digit
Second Character	Decimal point
Third Character	Voltage - Second digit
Fourth Character	Voltage - Third digit
Fifth Character	Polarity
Sixth Character	Mode
Seventh Character	Current - Most significant digit
Eighth Character	Current - Second digit

For voltage up to 49.9 volts (X10 range):

First Character	Voltage - Most significant digit
Second Character	Voltage - Second digit
Third Character	Decimal point
Fourth Character	Voltage - Third digit
Fifth Character	Polarity
Sixth Character	Mode
Seventh Character	Current - Most significant digit
Eighth Character	Current - Second digit

Allow 5 milliseconds minimum between successive decimal point location changes. Allow 200 milliseconds minimum between successive polarity changes.

DATA INPUT LOGIC POLARITY

Standard LF-9-04 power supplies are factory wired for positive logic data input, but can readily be rewired for negative logic by rewiring jumpers on printed circuit board "B". See table I below for proper jumper wiring.

TABLE I

FUNCTION	JUMPER	
	LF-9-04 with positive logic and LF-9-04-GPIB	LF-9-04 with negative logic
Data Lines	B1 to B2	B1 to B3
Data Flag	A1 to A2	A1 to A3
Final Transfer	C1 to C2	No jumper

Model LF-9-04-GPIB is factory wired for negative data input logic as specified by IEEE Standard no. 488-1975. Polarity of data input logic cannot be changed.

ADDRESS SELECTION ("GPIB" option only)

Select desired address on address switch using a pointed object to place switch in proper position. Switch no. 1 is least significant digit (DIO-"1"). "ON" position of switch corresponds to logic "1".

8, 12, OR 24 BIT BCD SYSTEM PROGRAMMING (Not applicable for "GPIB" option)

Voltage Programming

X1 Range. Voltage programming input consists of three BCD digits plus one bit each for polarity and gain. If the desired output is +2.04 volts, the most significant digit will be 2, the second digit will be 0, the third digit will be 4, the gain bit will be logic "0" (X1 range), and the polarity bit will be logic "0" (positive). The power supply will then multiply this number by one. The result will be 2.04 x 1 = +2.04 volts.

X5 Range. Voltage programming input consists of three BCD digits plus one bit each for polarity and gain. When using the X5 range, the programmed voltage number is to be 1/5 of the desired output voltage. For example: If the desired output voltage is 40.8 volts, 40.8/5 = 8.16. The most significant digit programmed will be 8, the second digit will be 1, the third digit will be 6, and the gain bit will be logic "1" (X5 range), and the polarity bit will be logic "0" (positive). The power supply will then multiply this number by five. The result will be 8.16 x 5 = +40.8 volts.

Current Programming. Current programming consists of two BCD digits or one bit for current limit override. Current programming is entered as a percentage of 2.0 amps. If the desired current limit crossover point is 1.5 amps, the programming data entered is 75%. The most significant digit is 7. The second digit is 5. The result will be 75% of 2.0 amps = 1.5 amps. If the current limit override bit is entered as logic "1", the current limit crossover point will automatically be programmed to approximately 110% of the maximum rated current. No other current programming will be required.

An incorrect entry can be corrected by stopping the programming sequence and starting again at the beginning. The power supply output will not be programmed until the final transfer pulse is entered.

Zero Override. Low signal input ($0.0V \leq V_{IN} \leq 0.8V$) must be maintained at pin 20 of the data input connector for normal power supply operation. A high signal input ($2.0V \leq V_{IN} \leq 5.0V$) will activate the zero override feature. Zero override is automatically activated when data plug is disconnected.

ASCII PROGRAMMING

Voltage Programming. ASCII Voltage Programming consists of five characters including one character each for decimal point (.) and polarity. If the desired output voltage is +21.6 volts; the first character will be 2 (ASCII code 262); the second character will be 1 (ASCII code 261); the third character will be "." (ASCII code 256); the fourth character will be 6 (ASCII code 266); the fifth character will be "+" (ASCII code 253).

Current Programming. ASCII current programming consists of two characters which make up character numbers 6 and 7 of the complete seven character ASCII word. Current programming is entered as a percentage of 2.0 amps. If the desired current limit crossover point is 1.0 amp, the programming data entered is 50%. The sixth ASCII character will be 5 (ASCII code 265). The seventh character will be 0 (ASCII code 260). (These correspond to the seventh and eighth characters respectively for the GPIB option.) The result will be 50% of 2.0 amps = 1.0 amp.

An income ASCII word can be terminated and cleared by programming the ASCII character comma (ASCII code 254).

Zero Override.* Low signal input ($0.0V \leq V_{IN} \leq 0.8V$) must be maintained at pin 20 of the data input connector for normal power supply operation. A high signal input ($2.0V \leq V_{IN} \leq 5.0V$) will activate the zero override feature. Zero override is automatically activated when data plug is disconnected.

*Not applicable for GPIB option.

OUTPUT POLARITY CHANGE (Not applicable for "GPIB" option)

When a polarity change is programmed, the busy/ready flag will indicate "busy" for approximately 42 milliseconds for a change from positive to negative and 83 milliseconds for a change from negative to positive. A "ready" signal will then be given. The polarity of the output, however, may change before the output falls to zero. If the load capacity is in excess of 1000 mf, the busy/ready flag may erroneously indicate "ready" before the output has reached zero. For applications where load capacity exceeds 1000 mf, the supply should be programmed for zero volts output and allowed to reach zero (25ms/1000 mf load capacity) before a polarity change is programmed. Allow 200 milliseconds minimum between successive polarity changes.

OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermostat Shutdown. The thermostat opens the input circuit only when the temperature of the transistor heat radiator exceeds a maximum safe value. The thermostat will automatically reset when the temperature of the heat sink decreases to a safe operating value.

Overvoltage Shutdown (If optional LHOV-6 Overvoltage Protector is used). When the power supply output voltage increases above the overvoltage limit, the LHOV-6 Overvoltage Protector will short circuit output of the supply. After eliminating the cause(s) for overvoltage, resume operation of the supply either by momentarily interrupting the AC input circuit or by programming the output to zero volts and zero amperes.

MAINTENANCE

GENERAL

This section describes trouble analysis routine, calibration and test procedures that are useful for servicing the Lambda power supply. A trouble chart is provided as an aid for the troubleshooter. Refer to the section on SPECIFICATIONS AND FEATURES for the minimum performance standards.

TROUBLE ANALYSIS

Whenever trouble occurs, systematically check all fuses, primary power lines, external circuit elements, and external wiring for malfunction before troubleshooting the equipment. Failures and malfunctions often can be traced to simple causes such as improper jumpers and supply-load connections or fuse failure due to metal fatigue.

Use the electrical schematic diagram and block diagram, figure 9, as an aid to locating trouble causes. The schematic diagram contains various circuit voltages that are averages for normal no load operation. Measure these voltages using the conditions for measurement specified on the schematic diagram. Use measuring probes carefully to avoid causing short circuits and damaging circuit components.

CHECKING TRANSISTORS AND CAPACITORS

Check transistors with an in-circuit transistor checker. If no checker is available, transistors can be checked with an ohmmeter that has a highly limited current capability. Observe proper polarity for PNP or NPN to avoid error in measurement. The forward transistor resistance is low but never ZERO; backward resistance is always higher than the forward resistance.

Do not assume trouble is eliminated when only one part is replaced. This is especially true when one transistor fails, causing other transistors to fail. Replacing only one transistor and turning power on, before checking for additional faulty components could damage the replaced component.

When soldering semi-conductor devices, hold the lead being soldered with a pair of pliers or a commercial heat sink device placed between the component and the solder joint.

NOTE: The leakage resistance obtained from a simple resistance check of a capacitor is not always an indication of a faulty capacitor. In all cases the capacitors are shunted with resistances, some of which have low values. Only a dead short is a true indication of a shorted capacitor.

PRINTED CIRCUIT BOARD MAINTENANCE TECHNIQUES

1. If foil is intact, but not covered with solder, it is a good contact. Do not attempt to cover with solder.
2. Voltage measurements can be made from either side of the board. Use a needle-point probe to penetrate to the wiring whenever a protective coating is used on the wiring. A brass probe can be soldered to an alligator clip adapted to measuring instrument.
3. Always use a heat sink when soldering transistors; a transistor pad with mounting feet is an effective heat sink.
4. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

5. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process described below:

   a) Select a 3/16 inch tinned copper braid for use as a wick; if braid is not available, select AWG No. 14 or No. 16 stranded wire with 1/2 inch insulation removed.

   b) Dip the wick in liquid rosin flux.

   c) Place the wick onto the soldered connection and apply soldering iron onto the wick.

   d) When sufficient amount of solder flows onto the wick, freeing the component, simultaneously remove iron and wick.

TROUBLE CHART

The trouble chart is intended as a guide for locating trouble causes, and is used along with the schematic diagram.

The operating conditions assumed for the trouble chart are as follows:

a) AC power of proper voltage and frequency is present at input terminals.

b) Either V1 or V2 terminal is connected to chassis ground.

c) The power supply is connected for constant voltage with local sensing. See Analog Section schematic; dotted lines on TB1 indicate jumpers connected for local sensing.

d) Power supply has been programmed for +9.99 volts output at 99% current.

TROUBLE SHOOTING CHART

Symptom	Possible Cause	Remedy
1. Zero volts DC output.	Open F1, F2, F4.	Check and replace as necessary.
	Short circuit across output of supply.	Check load and load connections, correct as necessary.
	Series regulator section open	Check Q9 through Q13 and R25 through R29 for open, replace as necessary.
	Current sensing resistor open	Check R51 for open, replace as necessary.
	Thermostat S1 open	Refer to SPECIFICATIONS AND FEATURES for current ratings at given ambient temperature. After allowing time for the power supply to cool, resume operation of the supply.
2. Output voltage too high.	Open sense lead	Check load and load connections, correct as necessary.

TROUBLE SHOOTING CHART (Contd)

	Symptom	Possible Cause	Remedy
3.	Output voltage or current other than programmed value, voltage at P.C. term B18 and between terminals B4 and B3 are correct.	Defective component in Analog section	Refer to Symptom 6, 7, or 12.
4.	Same as 3, voltage between P.C. terminals B4 and B3 is not correct.		Disconnect wire from P.C. terminal B4 and remeasure. If correct, problem is in Analog section. Refer to Symptom 6, 7, or 12. If not correct, problem is in Digital section. Refer to Symptom 8 through 11 or 13, as applicable.
5.	Same as 3, voltage at P.C. terminal B18 not correct.		Disconnect wire from P.C. terminal 18 and remeasure. If correct, refer to Symptom 3 or 4, as applicable. If not correct, problem is in Digital section. Refer to Symptom 8 through 11 or 13, as applicable.
6.	Output voltage too low, caused by faulty Analog component as determined in Symptom 3 or 4.	Open Q2, Q8 Shorted Q3, Q6, Q1, Q7	Check and replace as necessary.
		Q3 turned on by faulty Q111, Q112	Check and replace as necessary.
		Faulty CR20, CR21, CR23, CR24, CR25, CR32, CR29, CR30, CR33, CR34	Check and replace as necessary.
7.	Output voltage too high, caused by faulty Analog component as determined in Symptom 3 or 4.	Shorted Q2, Q8	Check and replace as necessary.
		Faulty K2	Check and replace as necessary.
		Faulty R1 through R4	Check and replace as necessary.
		IC1 faulty	Check and replace as necessary.

TROUBLE SHOOTING CHART (Contd)

Symptom	Possible Cause	Remedy
8. Output voltage too low, caused by faulty Digital component as determined in Symptom 4 or 5	Zero override signal activated (Q114 base at logic "1")	Check programming and programming connections. Check IC109, IC117, IC132, IC103, IC105, Q114; replace as necessary.
	Q112 turned off by faulty Q111, Q110, Q116	Check and replace as necessary.
9. Output voltage or current other than programmed value, caused by faulty digital component as determined in Symptom 4 or 5 (voltage at DAC101 pin 5 not correct).	Improper adjustment of R152	Adjust as necessary.
	Faulty CR107, CR106, IC136	Check and replace as necessary.
10. Same as 9 (voltage at DAC102 pin 5 not correct)	Improper adjustment of R153	Adjust as necessary.
	Faulty CR107, CR106, IC136	Check and replace as necessary.
11. Same as 9 (voltages at DAC101 pin 5 and DAC102 pin 5 are correct).	Faulty CR108, CR110, CR111, CR116, CR112, CR113, CR114, CR117, CR115, CR109, CR115, IC136	Check and replace as necessary.
12. Output current otner than programmed value, caused by faulty Analog component as determined in Symptom 3 or 4.	Faulty CR27, CR28, CR22, CR19, Q4, Q5, Q1, Q7, Q14 through Q17, IC2.	Check and replace as necessary.
13. Output current too high, caused by faulty Digital component as determined in Symptom 4 or 5.	Current limit override signal activated (Q115 base at logic "0").	Check programming. Check IC132, IC117, IC123; replace as necessary.
14. Output polarity not programmable.	Faulty CR31, K2, Q109, Q108, IC103.	Check and replace as necessary.
15. Gain does not program properly.	Faulty CR17, K1, R1, R2, R3, R4, Q107, IC103.	Check and replace as necessary.
16. Power supply sinks current when turned on.	Faulty Q6, Q7, Q14, Q15, Q16, CR33, CR34	Check and replace as necessary.

TROUBLE SHOOTING CHART (Contd)

	Symptom	Possible Cause	Remedy
17.	Power supply does not sink current.	Open Q6, Q7, Q14, Q15, Q16, CR33, CR34, R50, R47, R48, R49.	Check and replace as necessary.
		Faulty CR35	Check and replace as necessary.
18.	High ripple and unregulated DC output.	Open sense lead.	Check load and load connections, correct as necessary.
		Series regulator section shorted.	Check Q9 through Q13 for short, replace as necessary.
19.	Output ripple too high.	Faulty C1, C19, K2	Check and replace as necessary.

PERFORMANCE CHECKS

Checks With Constant Voltage Operation

Check the ripple and regulation of the power supply using the test connection diagram shown in figure 10. Use suggested test equipment or equivalent to obtain accurate results. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Set the differential meter, DC DVM (John Fluke Model 891A or equivalent) to the power supply operating voltage (49.95). Check the power supply load regulation accuracy while switching from the load to no-load condition. Long load leads should be a twisted pair to minimize AC pick-up.

Use a Variac to vary the line voltage from 105-132 or 132-105 AC and check the power-supply line regulation accuracy on the differential meter.

Use an oscilloscope to measure peak-to-peak ripple voltage of the power supply. DC output.

Checks With Constant Current Operation

Check the ripple or regulation of the power supply using the test connection diagram shown in figure 11. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Check the power supply load regulation accuracy while switching from the short circuit to load condition. Measure the voltage across 0.25 ohm, 5w, ww, sensing resistor Rs. Use John Fluke Model 891A or equivalent for the DVM connected across Rs. To obtain regulation figure substitute values obtained into regulation formula:

$$\frac{\Delta E}{Rs} = \frac{\Delta E}{0.25} = \text{Regulation in milliamperes,}$$

where ΔE is the voltage change in millivolts.

Use a Variac to vary the line voltage from 105-132 or 132-105 volts AC and check the power supply line regulation accuracy using the VTVM and the regulation formula:

$$\frac{\Delta E}{0.25}$$

"GPIB" Option Programming

Check power supply operation using a controller (Tektronix model 4051 or equivalent) programmed in accordance with IEEE Standard no. 488-1975. A data input mating connector (Amphenol no. 57-10240) is supplied to allow for "hard wiring" an input to the unit for incoming inspection purposes. Refer to figure 7 for data input connector pin functions.

CALIBRATION

In order to ensure compliance with specifications, the unit should be calibrated every thirty days or whenever DAC101, DAC102, IC1, IC2, IC136, Q2, Q8, Q9 through Q13, R1 through R4, R25 through R29, R32, R34, R51, R152, R153, R159, or R162 is replaced. To calibrate the unit adjust R152, R153, R159 and R162 as follows. The adjustment procedure requires that the power supply is removed from associated equipment, is at an ambient temperature of 25 - 30°C, and is stabilized and not operating.

1. Remove AC input power to the supply.
2. Connect power supply for local sensing operation as shown in figure 3, with no external load.
3. Apply AC input power to the supply.
4. Program the power supply for +0.00 volts (using X5 range) or +00.0 volts (using X10 range) with current limit crossover point at 50%.
5. Break seal on wiper of R159.
6. Using differential meter, John Fluke Model 891A or equivalent, adjust R159 for zero volts ± 1 mv output.
7. Program power supply for +9.99 volts with current limit crossover point at 50%.
8. Break seal on wiper of R152 and adjust for +9.99 volts output.
9. Remove AC input power to the supply.
10. Place a DC ammeter across output terminals 4 and 6.
11. Apply AC input power to the supply.
12. Program the power supply for +1.00 volt with current limit crossover point at 00%.
13. Break seal on wiper of R162 and adjust for +2.00 milliamperes output.
14. Adjust ammeter to scale suitable for measuring 1.98 amps.
15. Program the power supply for +1.00 volt with current limit crossover at 99%.
16. Break seal on wiper of R153 and adjust for +1.98 amps output.
17. After adjustment is completed, remove AC input power to the supply and use glyptol sealant to seal wipers of R152, R153, R159, and R162 to resistor housing.
18. After sealing, check settings and repeat adjustment procedure if required.

SERVICE

When additional instructions are required or repair service is desired, contact the nearest Lambda office where trained personnel and complete facilities are ready to assist you.

Please include the power supply model and serial number together with complete details of the problem. On receipt of this information, Lambda will supply service data or advice shipping for factory repair service.

All repairs not covered by the warranty will be billed at cost and an estimate forwarded for approval before work is started.

PARTS ORDERING

Standard components and special components used in the Lambda power supply can be obtained from the factory. In case of emergency, critical spare parts are available through any Lambda office.

The following information must be included when ordering parts:

1. Model number and serial number of power supply and purchase date.
2. Lambda part number.
3. Description of part together with circuit designation.
4. If part is not electronic part, or is not listed, provide a description, function, and location, of the part.

PARTS LIST

The electrical parts located on Lambda model LF-9-04 are listed here. In addition there are separate listings of parts for the "GPIB" and "V" options, and the LHOV-6 accessory.

MODEL LF-9-04

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
C1	Cap., elect., 3,600 mf -10 +100%, 75 vdc	CBS-36-020
C2	Cap., elect., 2,000 mf -10 +100%, 7 5 vdc	CBS-20-063
C3*	Cap., elect., 400 mf -10 +100%, 100 vdc	CBR-40-044
C4	Cap., elect., 400 mf -10 +100%, 30 vdc	CBR-40-034
C5	Cap., elect., 1,900 mf -10 +100%, 16 vdc	CBS-19-073
C6, C7	Cap., elect., 20 mf -10 +50%, 60 vdc	CBP-20-073
C8	Cap., elect., 100 mf -10 +100%, 25 vdc	CBR-10-078
C9	Cap., mylar, 0.0068 mf ±10%, 400 vdc	CGK-68-005
C10 thru C13	Cap., mylar, 0.033 mf ±10%, 400 vdc	CGL-33-006
C14*	Not assigned	
C15	Cap., elect., 1 mf ±20%, 35 vdc	CBN-10-009
C16*	Cap., ceramic, 18 pf ±5%, 1,000 vdc	CDH-18-001
C17*	Cap., ceramic, 470 pf ±20%, 1,000 vdc	CCJ-47-004
C18	Cap., elect., 12 mf -10 +100%, 100 vdc	CBP-12-041
C19	Cap., elect., 45 mf -10 +100%, 75 vdc	CBP-45-042
C20*	Not assigned	
C21	Cap., mylar, 0.047 mf ±10%, 200 vdc	CGL-47-018
C22 thru C24	Not assigned	
C25*	Cap., mylar, 0.47 mf ±10%, 200 vdc	CGM-47-009
C26	Not assigned	
C27*	Cap., ceramic, 240 pf ±20%, 1,000 vdc	CDJ-24-001
C28*	Cap., ceramic, 0.002 mf ±10%, 1,000 vdc	CDK-20-003
C29*	Same as C21	
C30*	Cap., mylar, 0.0068 mf ±10%, 200 vdc	CGK-68-001
C101	Cap., mica, 330 pf ±5%, 500 vdc	CCJ-33-001
C102*	Cap., mylar, 0.01 mf ±10%, 80 vdc	CGL-10-008
C103	Same as C101	
C104	Cap., mylar, 0.001 mf ±10%, 200 vdc	CGK-10-004
C105	Cap., mylar, 0.015 mf ±10%, 400 vdc	CGL-15-007
C106	Cap., mylar, 0.0022 mf ±10%, 400 vdc	CGK-22-010
C107, C108	Cap., mylar, 0.01 mf ±10%, 200 vdc	CGL-10-002

MODEL LF-9-04 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
C109	Cap., elect., 10 mf -10 +75%, 25 vdc	CBP-10-018
C110	Cap., elect., 3.3 mf ±20%, 35 vdc	CBN-33-019
C111	Cap., elect., 39 mf ±10%, 10 vdc	CBP-39-072
C112	Cap., mylar, 0.1 mf ±10%, 80 vdc	CGM-10-006
C113*	Cap., mylar, 0.33 mf ±10%, 80 vdc	CGM-33-012
C114	Not assigned	
C115	Same as C109	
C116	Same as C21	
C117*	Same as C113	
CR1 thru CR4	Rectifier	FBL-00-065
CR5 thru CR8	Rectifier	FBL-00-092
CR9, CR10	Same as CR1	
CR11 thru CR14	Rectifier	FBL-00-030
CR15, CR16	Same as CR5	
CR17	Same as CR11	
CR18	Rectifier, zener diode	FBM-Z118
CR19	Rectifier, zener diode	FBM-Z119
CR20, CR21	Same as CR11	
CR22, CR23	Rectifier	FBL-00-082
CR24, CR25	Same as CR11	
CR26 thru CR28	Same as CR22	
CR29 thru CR32	Same as CR11	
CR33*, CR34*	Not assigned	
CR35	Same as CR19	
CR36 thru CR39	Same as CR11	
CR101	Not assigned	
CR102	Same as CR11	
CR103	Rectifier, zener diode	FBM-Z109
CR104	Same as CR11	
CR105	Rectifier, zener diode	FBM-Z102
CR106*	Rectifier, zener diode	FBM-Z171
CR107	Same as CR22	
CR108*, CR109	Rectifier, zener diode	FBM-Z164
CR110 thru CR114	Same as CR22	

MODEL LF-9-04 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
CR115	Same as CR105	
CR116	Not assigned	
CR117	Same as CR22	
CR118	Same as CR103	
CR119*, CR120*	Same as CR22	
DAC101, DAC102	Integrated circuit, digital to analog converter	FBT-00-051
F1	Fuse, 3A, 3AG, SLO-BLO	FFC-03-000
F2, F3	Fuse, 4A, 3AG, NORM-BLO	FFB-04-000
F4	Fuse, 4A, 3AG, SLO-BLO	FFC-04-000
HC1	Hybrid circuit, overvoltage protector	L-12-OV-30
IC1, IC2	Integrated circuit, linear op-amp	FBT-00-050
IC3	Not assigned	
IC4	Integrated circuit, +15V regulator	FBT-00-047
IC5	Integrated circuit, -15V regulator	FBT-00-048
IC6	Integrated circuit, 5V regulator	FBT-00-046
IC101	Integrated circuit, quad 2 input and gate	FBT-00-059
IC102	Integrated circuit, quad 2 channel data selector	FBT-00-065
IC103	Integrated circuit, quad exclusive or gate	FBT-00-064
IC104	Integrated circuit, quad 2 input nand gate	FBT-00-056
IC105	Integrated circuit, triple 3 input nor gate	FBT-00-055
IC106	Integrated circuit, quad 2 input or gate	FBT-00-061
IC107, IC108	Integrated circuit, dual D flip-flop	FBT-00-043
IC109	Integrated circuit, triple 3 input nand gate	FBT-00-053
IC110, IC111	Integrated circuit, dual J-K flip-flop	FBT-00-058
IC112	Integrated circuit, decade counter	FBT-00-052
IC113 thru IC115	Integrated circuit, 8 bit shift register	FBT-00-063
IC116	Integrated circuit, 7 stage counter	FBT-00-062
IC117	Same as IC104	
IC118	Integrated circuit, quad 2 input nor gate	FBT-00-044
IC119 thru IC124	Integrated circuit, quad latch	FBT-00-060
IC125	Same as IC105	
IC126	Integrated circuit, dual 4 input nand gate	FBT-00-057
IC127	Same as IC118	
IC128, IC129	Integrated circuit, hex inverter/buffer	FBT-00-054
IC130	Same as IC101	
IC131	Same as IC104	
IC132	Same as IC128	
IC133 thru IC135	Integrated circuit, dual 4 bit shift register	FBT-00-066
IC136	Integrated circuit, quad op-amp	FBT-00-049

MODEL LF-9-04 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
K1	Relay, reed	FEJ-11-022
K2	Relay	FEJ-42-023
OC1, OC101 thru OC105	Optical coupler	FBN-L179
Q1	Transistor, NPN	FBN-L110
Q2, Q3*	Transistor, NPN	FBN-L108
Q4, Q5	Same as Q1	
Q6	Transistor, NPN	FBN-L109
Q7	Transistor, PNP	FBN-L118
Q8*	Transistor, NPN	FBN-L194
Q9 thru Q16	Transistor, NPN	FBN-36487
Q17*	Same as Q8	
Q101 thru Q106	Same as Q1	
Q107	Transistor, NPN	FBN-L113
Q108	Same as Q7	
Q109	Same as Q107	
Q110	Same as Q1	
Q111	Same as Q7	
Q112	Same as Q1	
Q113 thru Q115	Same as Q7	
Q116	Same as Q1	
Q117*	Same as Q7	
Q118*	Same as Q1	
R1	Res., ww, 12,500 ohms ±0.025%, 1/3w	DET-13-009
R2	Res., ww, 10,000 ohms ±0.025%, 1/3w	DET-10-010
R3, R4	Res., ww, 50,000 ohms ±0.025%, 1/3w	DET-50-011
R5	Res., comp., 10 ohms ±10%, ¼w	DCB-1001
R6	Res., comp., 4,700 ohms ±10%, ½w	DEB-4721
R7	Res., comp., 47,000 ohms ±10%, ½w	DEB-4731
R8	Res., comp., 10,000 ohms ±10%, ½w	DEB-1031
R9*	Res., comp., 33,000 ohms ±10%, ¼w	DCB-3331
R10	Res., comp., 7,500 ohms ±5%, ½w	DEB-7525
R11	Res., comp., 68,000 ohms ±10%, ½w	DEB-6831
R12	Res., comp., 22,000 ohms ±10%, ½w	DEB-2231
R13*	Res., comp., 470 ohms ±10%, ½w	DEB-4711
R14	Res., comp., 100,000 ohms ±10%, ¼w	DCB-1041
R15	Res., ww, 5,600 ohms ±3%, 3w	DFS-56-053
R16	Res., comp., 1,200 ohms ±10%, ½w	DEB-1221
R17	Res., comp., 1,000 ohms ±10%, ½w	DEB-1021
R18	Res., comp., 47 ohms ±5%, ½w	DEB-4705
R19, R20	Res., comp., 100 ohms ±5%, ½w	DEB-1015

MODEL LF-9-04 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
R21	Res., ww, 3,600 ohms ±3%, 3w	DFS-36-050
R22	Res., comp., 150 ohms ±5%, ½w	DEB-1515
R23	Same as R19	
R24*	Not assigned	
R25 thru R29	Res., ww, 1.25 ohms ±3%, 3w	DFN-13-051
R30, R31	Not assigned	
R32	Res., film, 9,090 ohms ±0.5%, ½w	DCS-90-103
R33	Not assigned	
R34	Res., film, 1,010 ohms ±0.5%, ½w	DCS-10-104
R35	Same as R17	
R36	Same as R8	
R37	Same as R12	
R38, R39	Same as R6	
R40	Res., comp., 2,200 ohms ±10%, ¼w	DCB-2221
R41	Same as R17	
R42	Same as R19	
R43*	Not assigned	
R44	Same as R19	
R45*	Res., comp., 4,700 ohms ±10%, ½w	DEB-4721
R46	Res., ww, 1,000 ohms ±3%, 5w	DFS-10-080
R47 thru R49	Res., ww, 2.7 ohms ±2%, 3w	DFN-27-053
R50	Res., comp., 240 ohms ±5%, ½w	DEB-2415
R51	Res., ww, 0.25 ohm ±5%, 5w	DFM-25-016
R52 thru R57	Res., ww, 0.3 ohm ±5%, 3w	DFM-30-053
R58	Same as R19	
R59	Not assigned	
R60*	Res., comp., 3,300 ohms ±10%, ¼w	DCB-3321
R61*	Res., comp., 1,200 ohms ±10%, ¼w	DCB-1221
R62*	Res., comp., 4,700 ohms ±10%, ¼w	DCB-4721
R101, R102	Same as R8	
R103	Same as R18	
R104, R105	Same as R19	
R106	Same as R18	
R107, R108	Same as R19	
R109, R110	Same as R6	
R111, R112	Same as R8	
R113	Same as R6	
R114 thru R119	Same as R8	
R120	Res., comp., 200 ohms ±5%, ½w	DEB-2015
R121	Same as R8	
R122, R123	Same as R12	

MODEL LF-9-04 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
R124	Same as R8	
R125	Res., comp., 1,000 ohms ±5%, ¼w	DCB-1025
R126	Res., comp., 1,800 ohms ±10%, ¼w	DCB-1821
R127, R128	Res., comp., 680 ohms ±5%, ½w	DEB-6815
R129	Same as R17	
R130	Same as R7	
R131	Not assigned	
R132*	Res., comp., 430 ohms ±5%, ½w	DEB-4315
R133	Res., comp., 3,000 ohms ±5%, ½w	DEB-3025
R134	Res., comp., 620 ohms ±5%, ½w	DEB-6215
R135	Same as R120	
R136	Same as R9	
R137, R138	Same as R8	
R139	Same as R40	
R140	Same as R14	
R141	Same as R12	
R142 thru R145	Same as R8	
R146	Same as R12	
R147	Res., comp., 330 ohms ±10%, ½w	DEB-3311
R148	Res., film, 560 ohms ±2%, ½w	DCR-56-002
R149	Res., film, 3,480 ohms ±1%, ¼w	DCS-35-078
R150	Res., film, 5,100 ohms ±2%, ¼w	DCS-51-051
R151	Same as R60	
R152	Res., var., cermet, 2,000 ohms ±10%, ½w	DRS-20-023
R153	Res., var., cermet, 5,000 ohms ±10%, ½w	DRS-50-024
R154	Same as R8	
R155	Same as R12	
R156	Same as R8	
R157	Res., comp., 1,500 ohms ±10%, ¼w	DCB-1521
R158	Res., comp., 4.7 megohms ±10%, ½w	DEB-4751
R159	Res., var., cermet, 10,000 ohms ±10%, ½w	DRT-10-049
R160	Same as R157	
R161	Res., comp., 330,000 ohms ±10%, ¼w	DCB-3341
R162	Same as R159	
R163	Same as R8	
R164	Same as R40	
R165, R166	Res., comp., 1.2 megohms ±5%, ½w	DEB-1255
R167	Res., comp., 75,000 ohms ±5%, ½w	DEB-7535
R168	Res., comp., 82,000 ohms ±10%, ¼w	DCB-8231
R169*, R170*	Same as R8	
R171*	Res., comp., 22,000 ohms ±10%, ¼w	DCB-2231
R172*	Same as R9	
R173*	Same as R157	
S1	Thermostat	FKA-155-020
T1	Transformer	ABA-LF-904-1

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
	*On units with serial no. prefix A. The parts listed below differ from subsequent units.	
C3	Cap., elect., 3,100 mf -10 +100%, 30 vdc	CBS-31-030
C14	Cap., mylar, 0.01 mf ±10%, 200 vdc	CGL-10-002
C16	Cap., mica, 470 pf ±5%, 500 vdc	CCJ-47-004
C17	Cap., mylar, 0.0047 mf ±10%, 200 vdc	CGK-47-002
C20	Cap., mylar, 0.033 mf ±10%, 400 vdc	CGL-33-006
C25	Not assigned	
C27	Cap., mica, 100 mf ±5%, 500 vdc	CCJ-10-007
C28	Cap., mylar, 0.01 mf ±10%, 200 vdc	CGL-10-002
C29, C30	Not assigned	
C102	Cap., mylar, 0.0047 mf ±10%, 200 vdc	CGK-47-002
C113, C117	Not assigned	
CR33, CR34	Rectifier	FBL-00-092
CR106	Rectifier, zener diode	FBM-Z123
CR108	Rectifier, zener diode	FBM-Z109
CR119, CR120	Not assigned	
Q3	Transistor, NPN	FBN-L109
Q8, Q17	Transistor, NPN	FBN-36487
Q117, Q118	Not assigned	
R9	Res., comp., 5,600 ohms ±5%, ¼w	DCB-5625
R13	Res., comp., 22 ohms ±10%, ½w	DEB-2201
R24	Res., ww, 5 ohms ±5%, 5w	DFN-50-025
R43	Res., comp., 620 ohms ±5%, ½w	DEB-6215
R45	Res., comp., 2,200 ohms ±5%, ½w	DEB-2225
R60 thru R62	Not assigned	
R132	Res., comp., 200 ohms ±5%, ½w	DEB-2015
R169 thru R173	Not assigned	

PARTS FOR "GPIB" OPTION

On model LF-9-04 with suffix "GPIB", the parts listed below change.

C5	Cap., elect., 3,800 mf -10 +75%, 15 vdc	CBS-38-165
C8	Cap., elect., 150 mf -10 +100%, 50 vdc	CBR-15-153
C106	Not assigned	
C201	Cap., elect., 1.5 mf ±10%, 15 vdc	CBN-15-047
C202	Cap., mylar, 0.0047 mf ±10%, 200 vdc	CGK-47-002

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
C203	Cap., mylar, 0.001 mf ±10%, 200 vdc	CGK-10-004
C204	Same as C202	
C205	Cap., mylar, 470 pf ±10%, 200 vdc	CGJ-47-002
C206	Cap., mylar, 0.01 mf ±10%, 200 vdc	CGL-10-002
C207	Same as C201	
C208	Same as C205	
C209	Cap., elect., 0.22 mf ±10%, 35 vdc	CBM-22-001
C210	Same as C206	
C211	Cap., mylar, 0.033 mf ±10%, 200 vdc	CGL-33-022
C212	Cap., mylar, 0.022 mf ±10%, 200 vdc	CGL-22-001
C213	Cap., mylar, 0.047 mf ±10%, 200 vdc	CGL-47-018
C214	Cap., mylar, 0.0015 mf ±10%, 200 vdc	CGK-15-017
CR201 thru CR215	Rectifier	FBL-000-082
CR216	Rectifier, zener diode	FBM-Z133
CR217 thru CR219	Same as CR201	
CR220	Same as CR216	
CR221	Same as CR201	
IC114, IC115	Not assigned	
IC201 thru IC205	Integrated circuit, hex inverter	FBT-00-084
IC206, IC207	Integrated circuit, quad 2 input nand gate	FBT-00-085
IC208	Integrated circuit, 5 bit magnitude comparator	FBT-00-086
IC209	Integrated circuit, dual 4 input nand gate	FBT-00-087
IC210	Integrated circuit, dual 4 input and gate	FBT-00-088
IC211	Integrated circuit, dual D flip-flop	FBT-00-089
IC212	Integrated circuit, triple 3 input nand gate	FBT-00-090
IC213, IC214	Integrated circuit, triple 3 input nor gate	FBT-00-091
IC215	Integrated circuit, triple 3 input and gate	FBT-00-092
IC216 thru IC219	Integrated circuit, quad 2 input or gate	FBT-00-093
IC220 thru IC222	Integrated circuit, quad 2 input and gate	FBT-00-094
IC223, IC224	Integrated circuit, quad 2 input nor gate	FBT-00-095
IC225, IC226	Integrated circuit, quad $\overline{S}$-$\overline{R}$ latch	FBT-00-096
IC227	Integrated circuit, quad 2 input exclusive or gate	FBT-00-097
IC228, IC229	Integrated circuit, quad 2 input nand (open collectors)	FBT-00-098
IC230, IC231	Same as IC206	
Q201, Q202	Transistor, PNP	FBN-L118

PARTS FOR "GPIB" OPTION (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
Q203	Transistor	FBN-L113
Q204	Same as Q201	
R146	Res., comp., 220,000 ohms ±10%, ½w	DEB-2241
R201 thru R216	Res., comp., 3,000 ohms ±5%, ½w	DEB-3025
R217 thru R232	Res., comp., 6,200 ohms ±5%, ½w	DEB-6225
R233	Res., comp., 51,000 ohms ±5%, ½w	DEB-5135
R234, R235	Not assigned	
R236, R237	Same as R201	
R238	Res., comp., 1,000 ohms ±5%, ½w	DEB-1025
R239, R240	Same as R201	
R241	Not assigned	
R242	Res., comp., 470 ohms ±5%, ½w	DEB-4715
R243	Same as R201	
R244 thru R248	Same as R217	
R249	Res., comp., 4,700 ohms ±10%, ½w	DEB-4721
R250, R251	Res., comp., 12,000 ohms ±5%, ½w	DEB-1235
R252	Res., comp., 1,500 ohms ±10%, ½w	DEB-1521
R253	Same as R217	
R254	Same as R242	
R255	Res., comp., 680 ohms ±5%, ½w	DEB-6815
R256	Not assigned	
R257	Res., comp., 5,600 ohms ±10%, ½w	DEB-5621
R258	Res., comp., 3,900 ohms ±10%, ½w	DEB-3921
R259	Res., comp., 100 ohms ±5%, ½w	DEB-1015
R260	Res., comp., 200 ohms ±5%, ½w	DEB-2015
R261	Same as R249	

PARTS FOR "GPIB" OPTION (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
R262	Res., comp., 2,700 ohms ±10%, ½w	DEB-2721
R263	Same as R238	
R264	Same as R201	
R265	Same as R258	
T1	Transformer	ABA-LF904-1

PARTS FOR "V" OPTION

On model LF-9-04 with suffix "V", capacitor C9 and fuse F1 change. Part no. changes for C9 and F1 are listed here.

C9	Cap., paper, 0.01 mf ±10%, 1,000 vdc	CAL-10-021
F1	Fuse, 1½A, 3AG, SLO-BLO	FFC-01-500

PARTS FOR OVERVOLTAGE PROTECTOR ACCESSORY MODEL LHOV-6

C1	Cap., mylar, 0.01 mf ±20%, 80 vdc	CGL-10-008
Q1	Transistor, NPN	FBN-L102
Q2	Transistor, PNP	FBN-L114
R1	Res., var., ww, 30,000 ohms ±10%, 1w	DNT-30-050
R2	Res., film, 560 ohms ±2%, ½w	DCR-56-002
R3	Res., film, 200 ohms ±5%, ½w	DCR-20-010
R4	Res., thermistor, 425 ohms ±5%, 1¼w	DKR-43-004
R5, R6	Res., comp., 1,200 ohms ±10%, ½w	DEB-1221
R7	Res., comp., 33 ohms ±5%, ¼w	DCB-3305
R8	Res., comp., 15,000 ohms ±10%, ½w	DEB-1531
R9	Res., comp., 22 ohms ±10%, ½w	DEB-2201
R10	Same as R5	
SCR1	Rectifier, silicon controlled	FBP-00-009

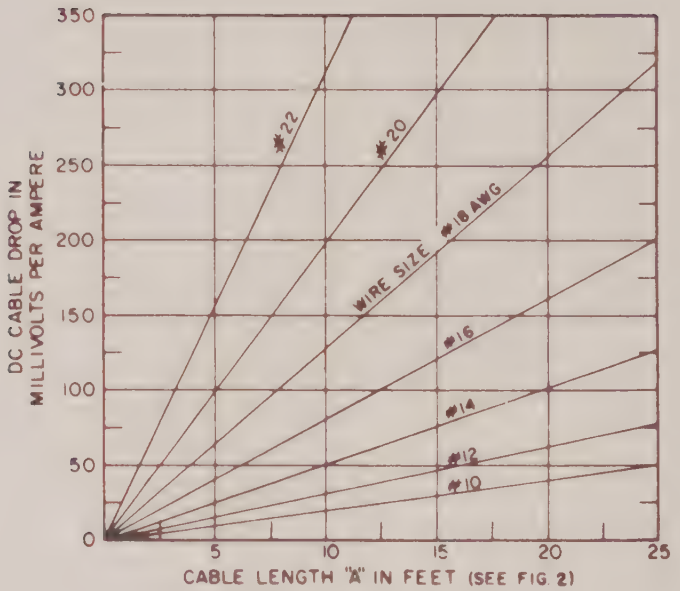


Figure 1. Cable Connection Chart

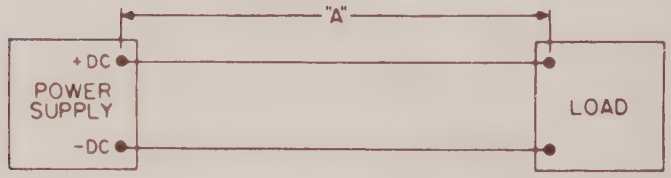
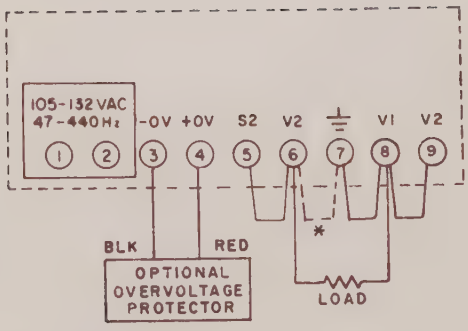
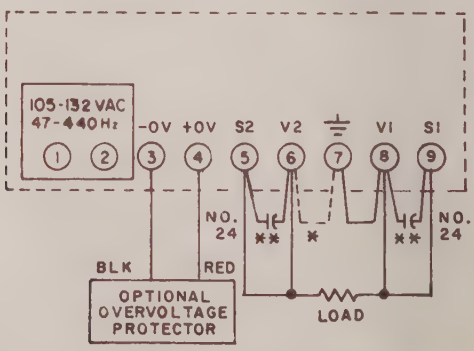


Figure 2. Cable Length "A" in Feet



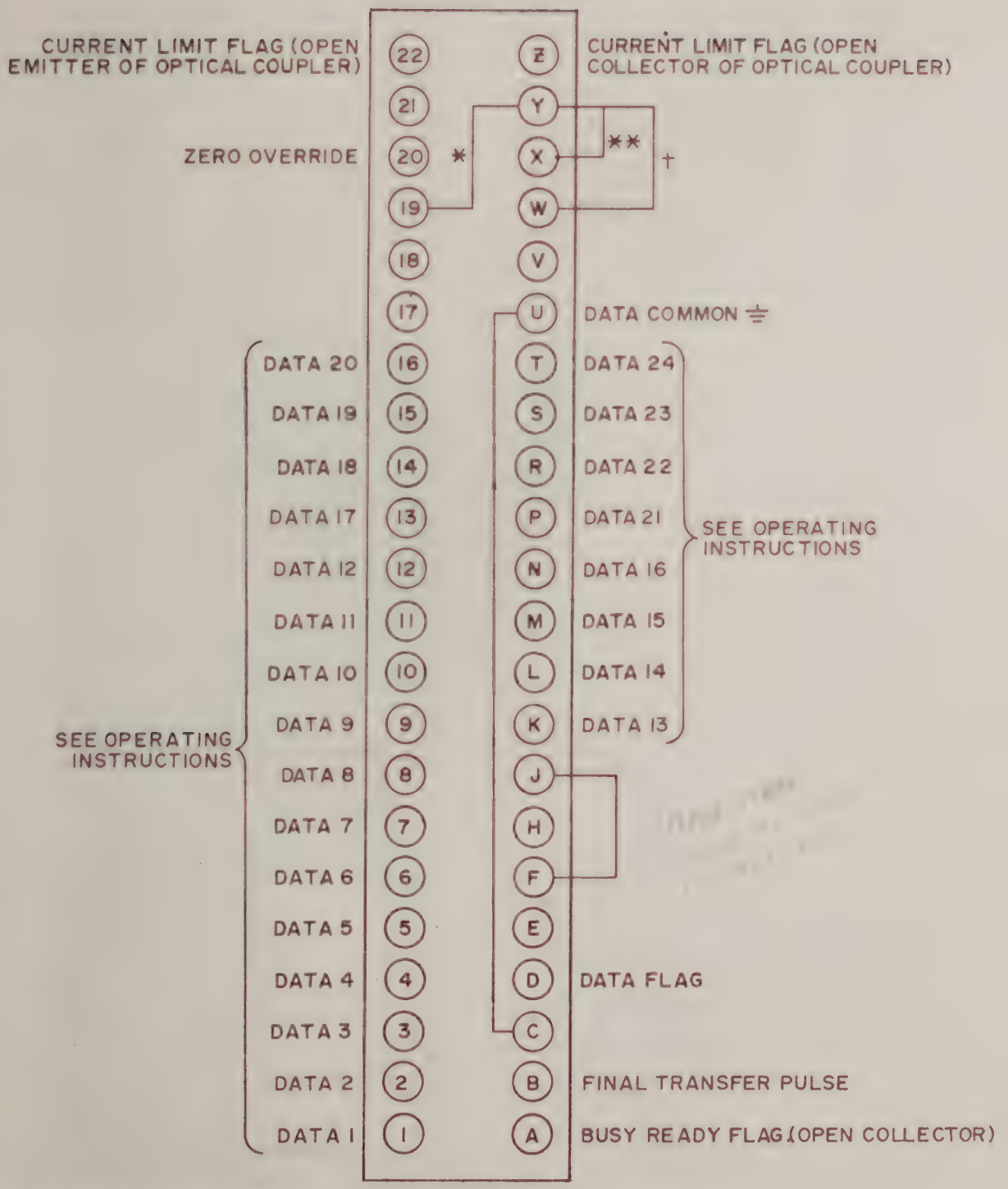
NOTE
* FOR V2 GROUND, DISCONNECT JUMPER FROM TERMINALS 7 AND 8 AND RECONNECT TO TERMINALS 6 AND 7.

Figure 3. Local Sensing Connection.



NOTE
* FOR V2 GROUND, DISCONNECT JUMPER FROM TERMINAL 7 AND 8 AND RECONNECT TO TERMINALS 6 AND 7.
** A 2.5 MF, NON-POLAR CAP MAY BE REQUIRED.

Figure 4. Remote Sensing Connection



* JUMPER PIN 19 TO PIN Y FOR PROGRAMMING IN BYTES OF 8 BITS EACH.
** JUMPER PIN X TO PIN Y FOR PROGRAMMING IN BYTES OF 12 BITS EACH.
† JUMPER PIN W TO PIN Y FOR PROGRAMMING IN BYTES OF 24 BITS EACH.

Figure 5. Data Input Connections; 8, 12, and 24 Bit BCD Systems.

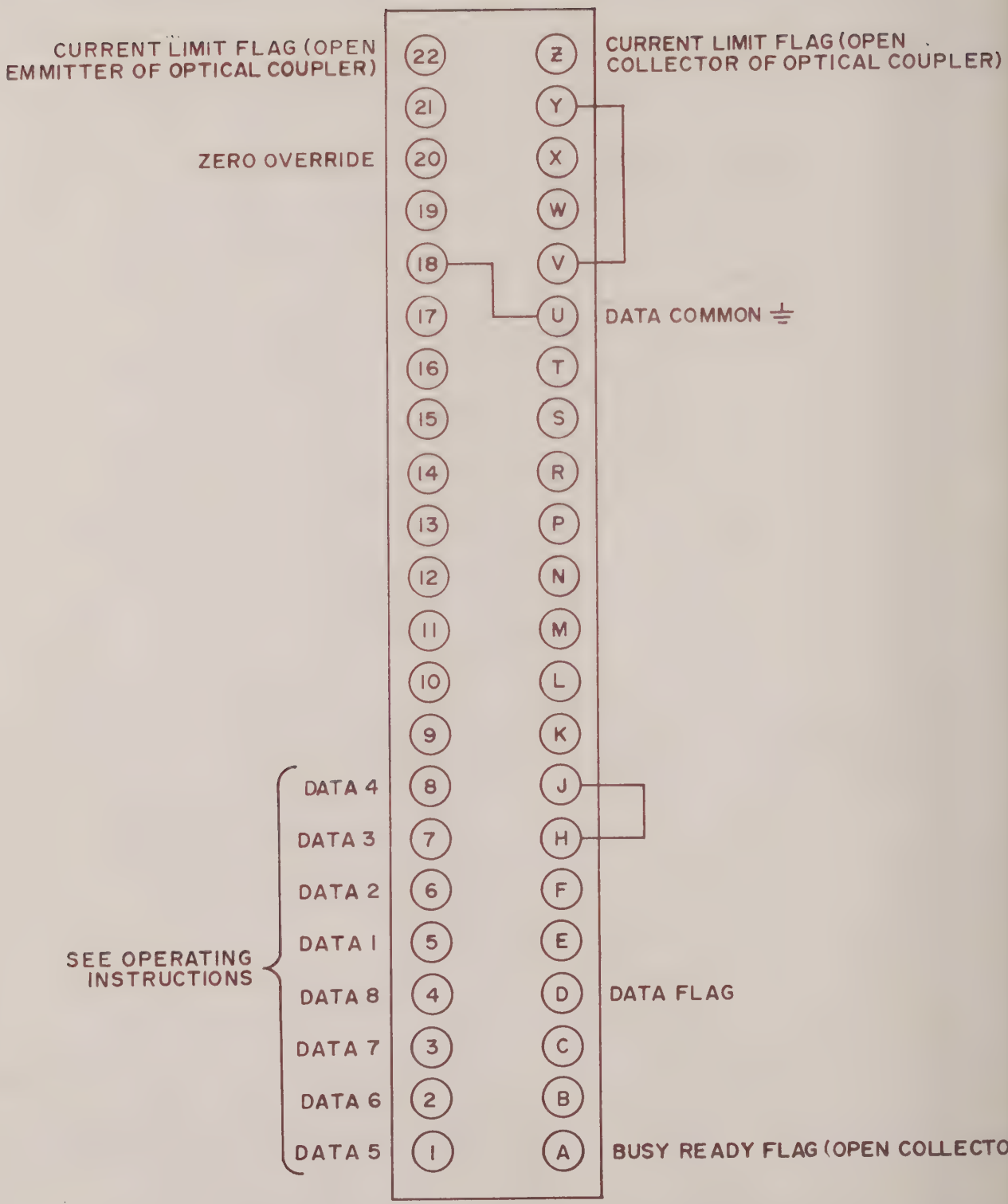


Figure 6. Data Input Connections, ASCII System.

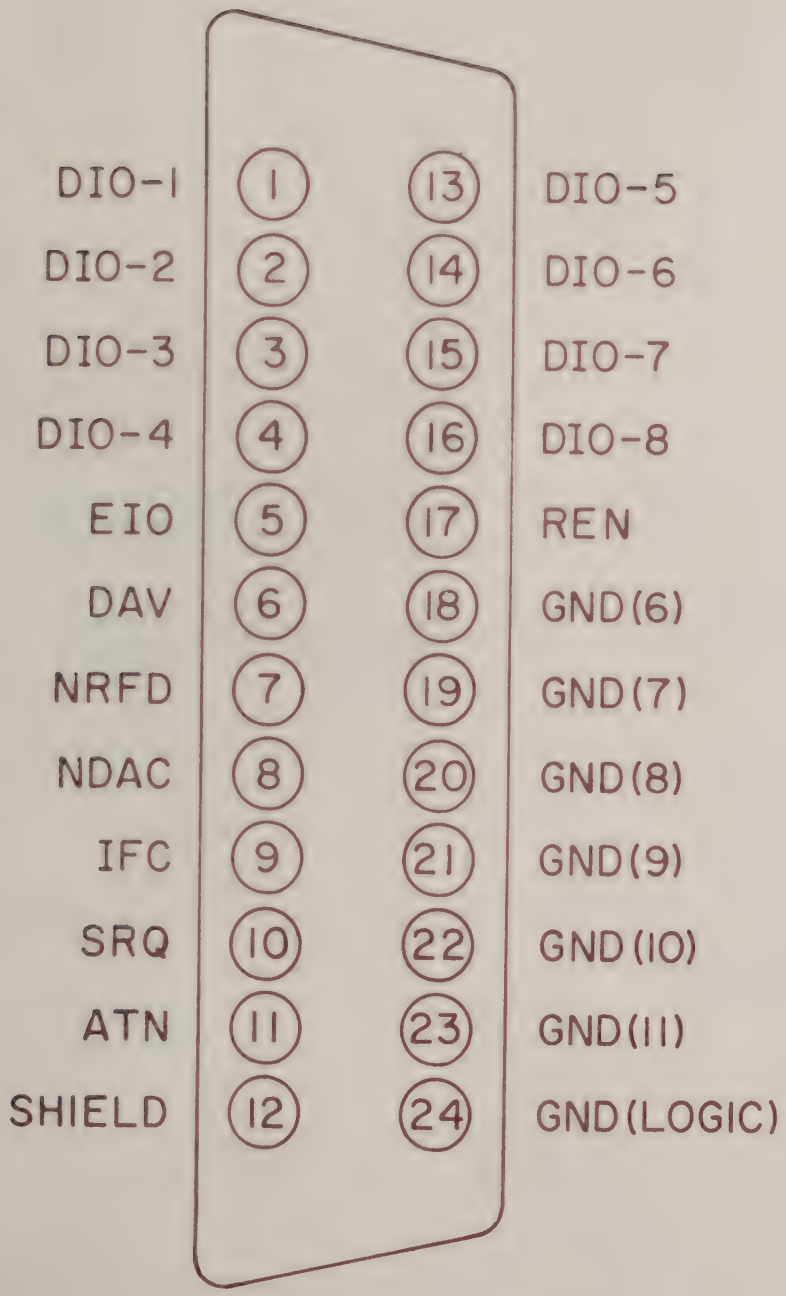


Figure 7. Data Input Connections, "GPIB" Option.

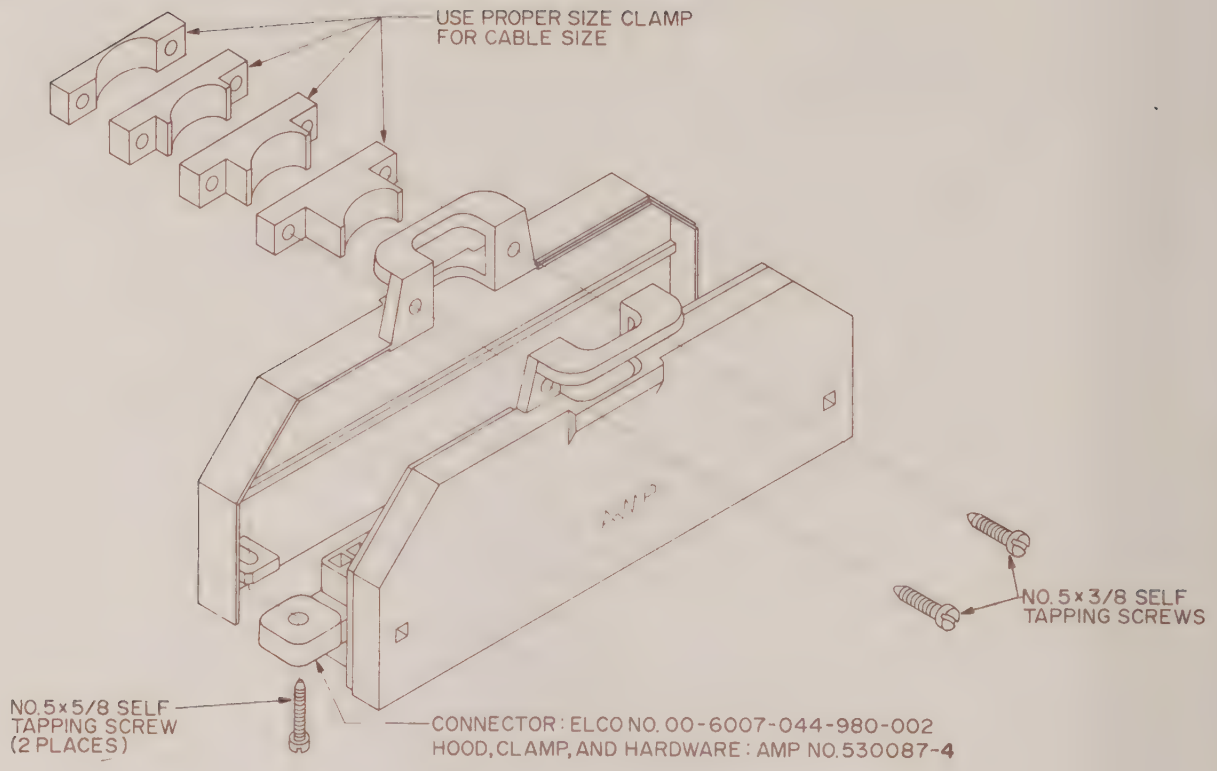


Figure 8. Data Input Connector and Hood Assembly.

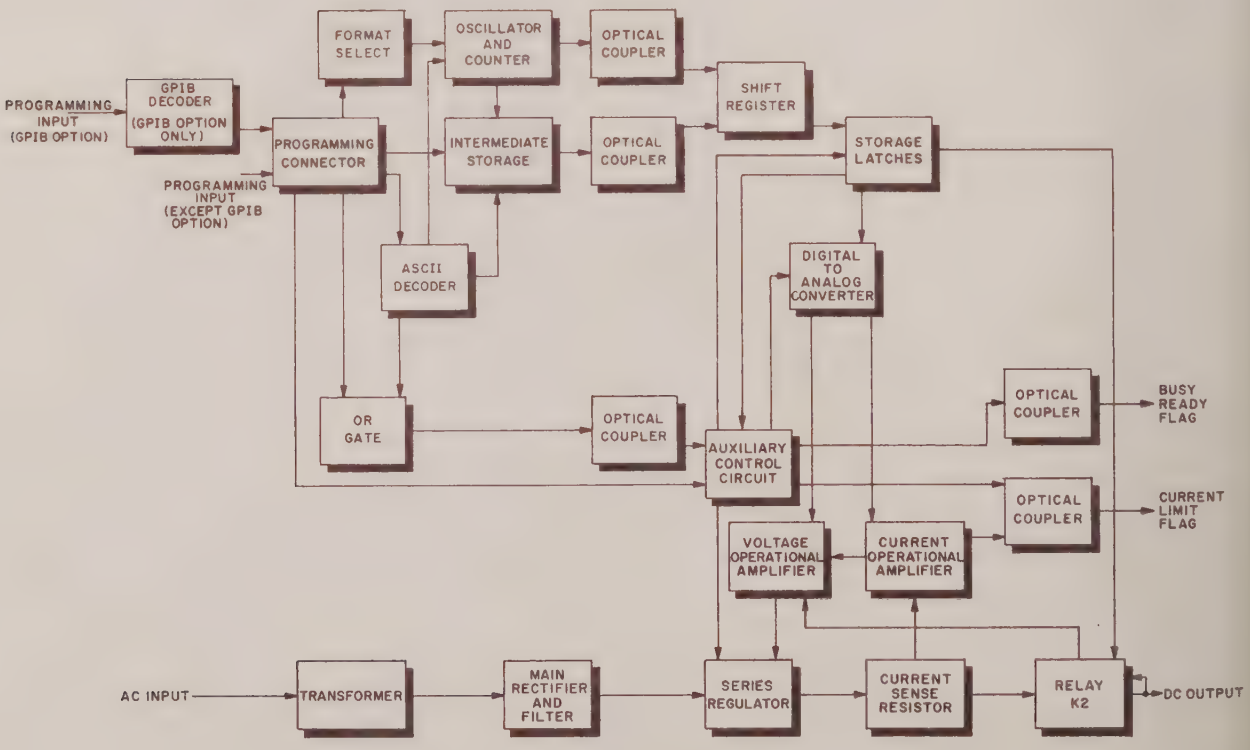
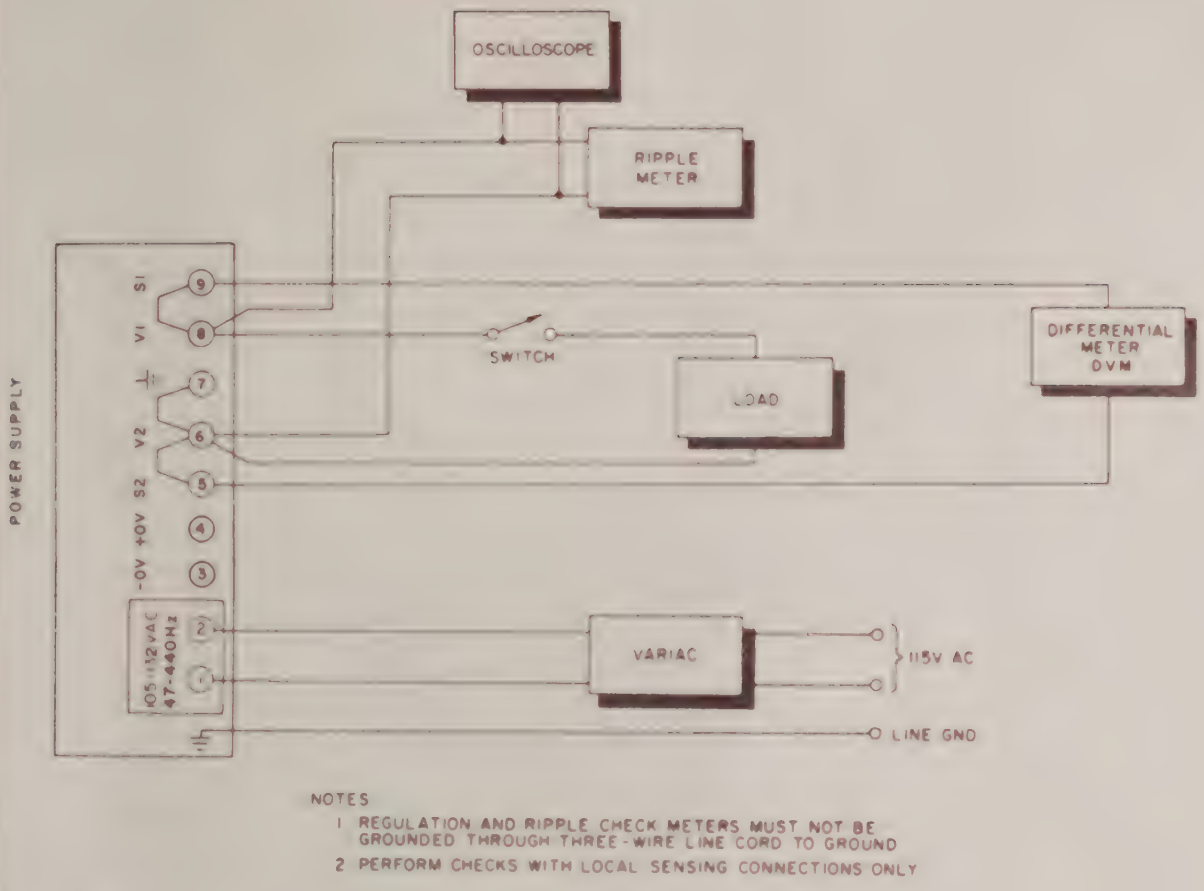


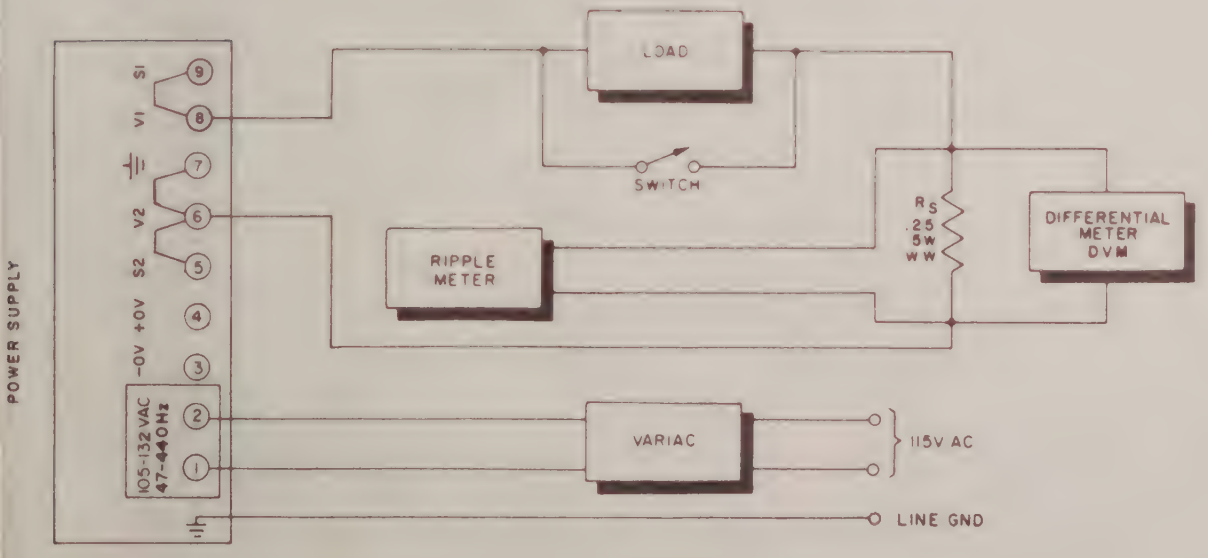
Figure 9. Typical Block Diagram.



NOTES

1. REGULATION AND RIPPLE CHECK METERS MUST NOT BE GROUNDED THROUGH THREE-WIRE LINE CORD TO GROUND
2. PERFORM CHECKS WITH LOCAL SENSING CONNECTIONS ONLY

Figure 10. Test Connections for Constant Voltage Performance Checks.



NOTES

1. REGULATION AND RIPPLE CHECK METERS MUST NOT BE GROUNDED THROUGH THREE-WIRE LINE CORD TO GROUND
2. PERFORM CHECKS WITH LOCAL SENSING CONNECTIONS ONLY

Figure 11. Test Connections for Constant Current Performance Checks.

NOTES:

1. "A" HOLES – 8-32 TAPPED HOLES (4) ON BOTTOM SURFACE FOR MOUNTING IN LRA-11 RACK ADAPTER AND FOR CUSTOMER CHASSIS MOUNTING.
   "B" HOLES – 8-32 TAPPED HOLES (4) ON BOTTOM SURFACE FOR MOUNTING IN LRA-10 RACK ADAPTER.
   "C" HOLES – 8-32 TAPPED HOLES (4) ON BOTTOM SURFACE FOR MOUNTING IN LRA-13 RACK ADAPTER.
2. TWO 6-32 TAPPED HOLES FOR MOUNTING OVERVOLTAGE PROTECTOR.
3. CUSTOMER MOUNTING SCREWS TO BE 3/8 LONG PLUS THICKNESS OF MOUNTING SURFACE.
4. CUSTOMER MUST PROVIDE CUTOUTS IN HIS MOUNTING SURFACE TO CLEAR VENTILATION PATTERNS AND ALLOW FREE AIR CIRCULATION.
5. DATA INPUT CARD EDGE CONNECTOR AND CONNECTOR HOOD KIT TO BE SUPPLIED BY LAMBDA FOR MODEL LF-9-04 ONLY.
6. DATA INPUT CONNECTOR J2, ADDRESS SWITCH AND COVER SHOWN SUPPLIED FOR LAMBDA MODEL LF-9-04-GPIB.

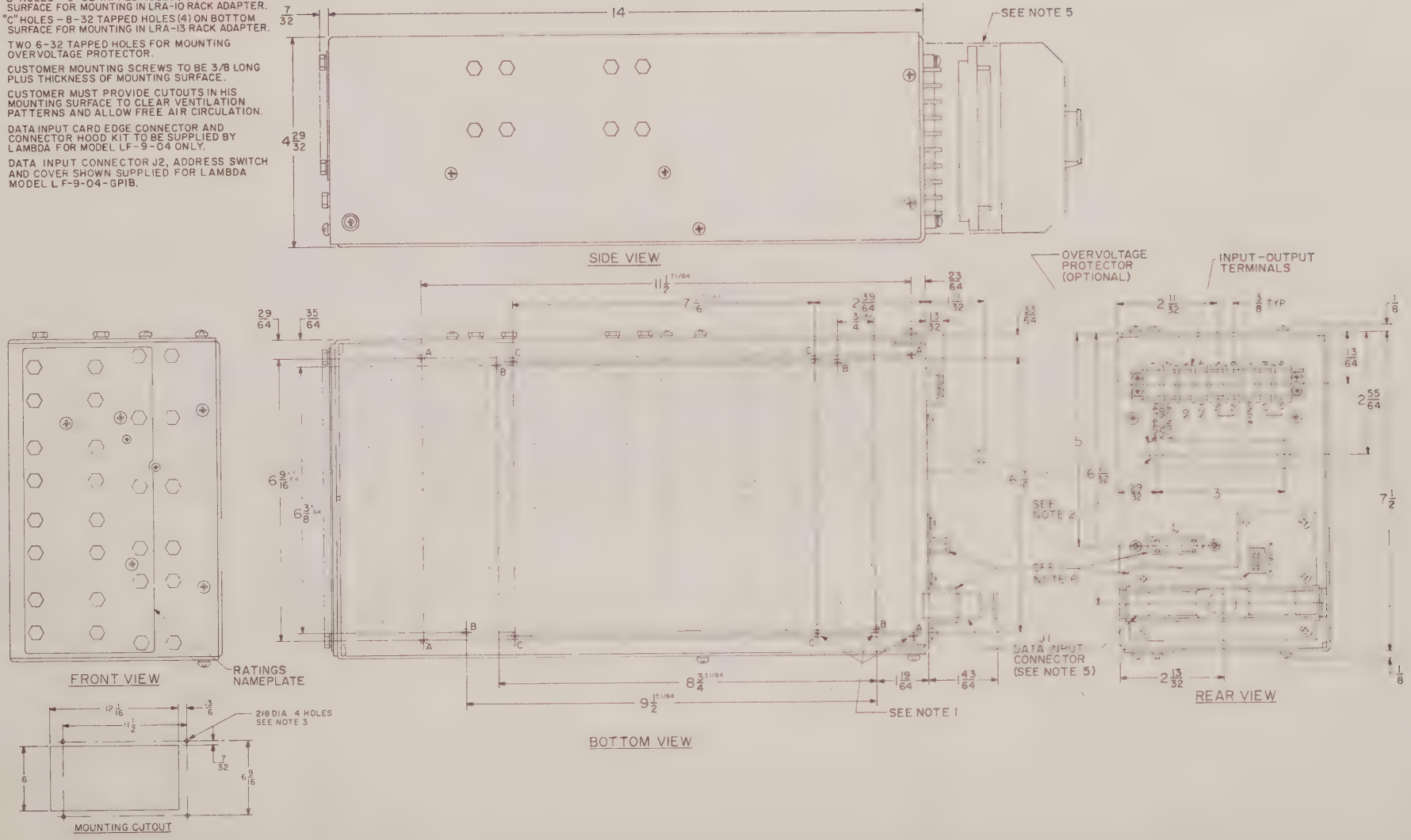
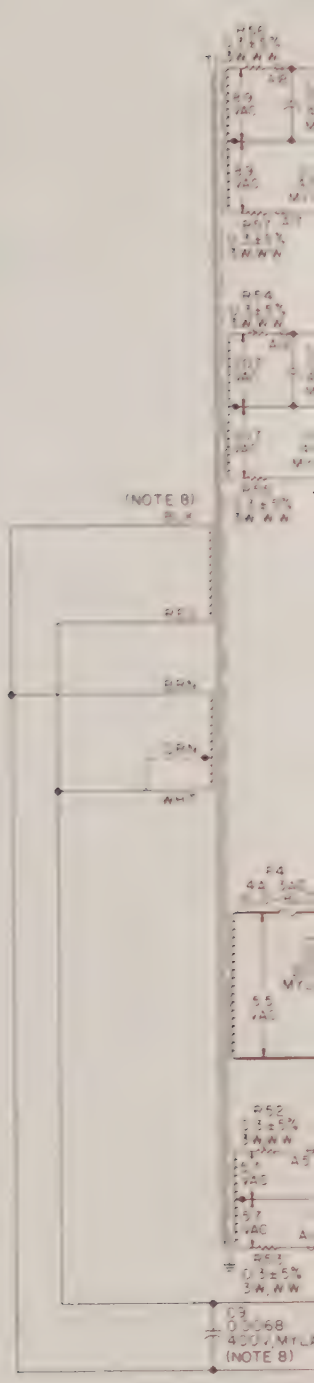
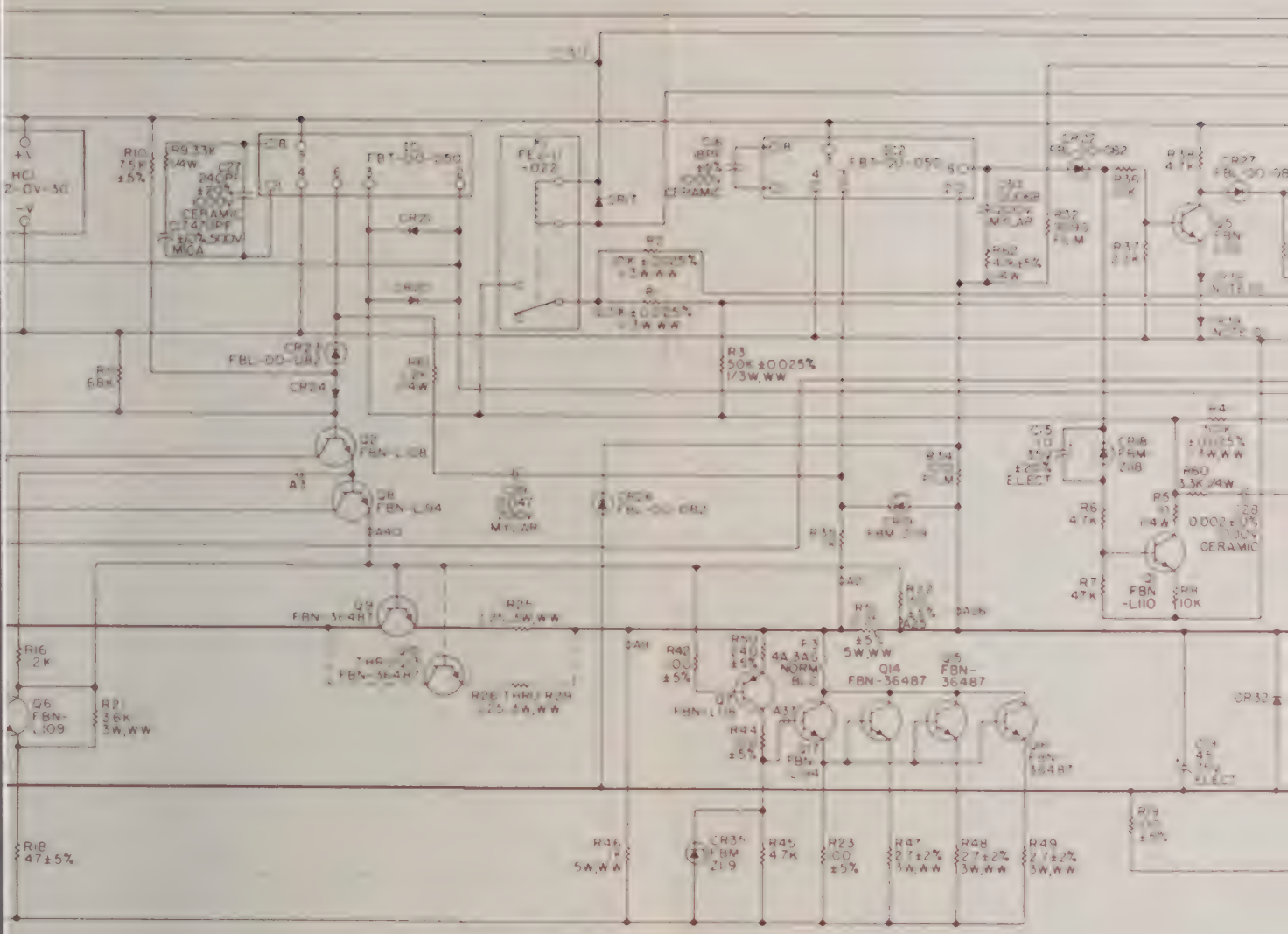


Figure 12. Outline Drawing.



NOTES

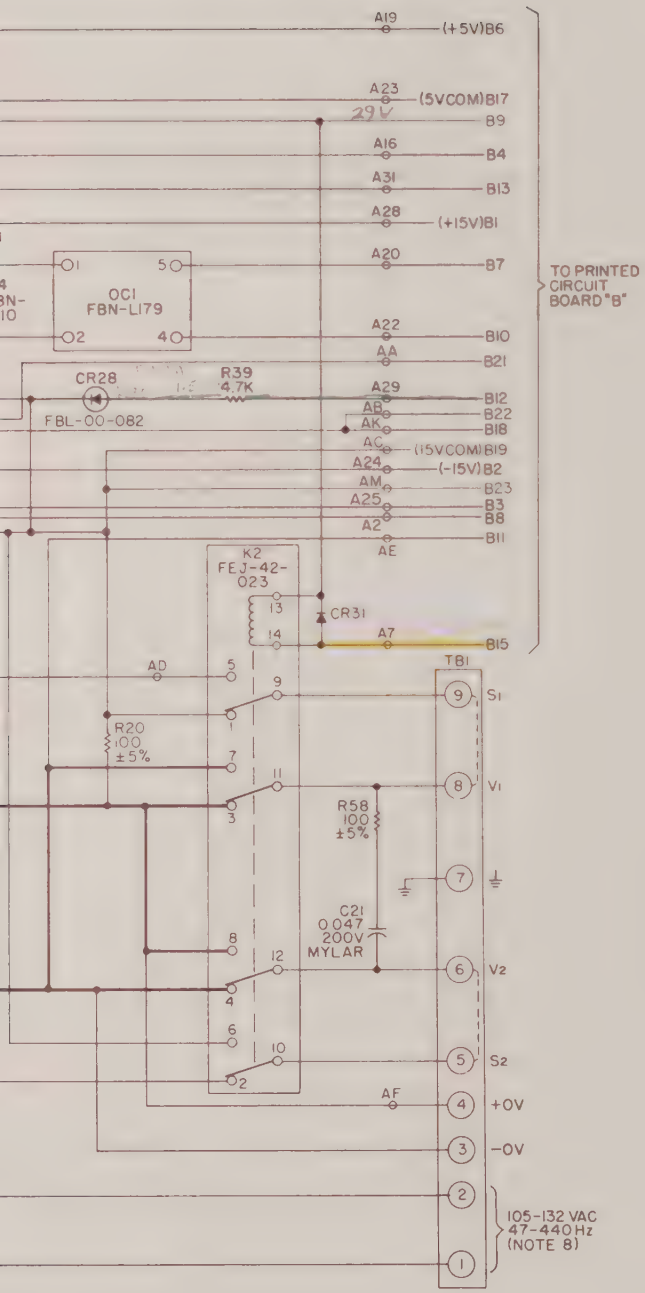
1. RESISTORS
IN OHMS UN
2. CAPACITOR
UNLESS O
3. RESISTOR
FILM ±0.5
4. CAPACITOR
-10 +100%
OTHERWIS
5. SYMBOLS
INDI
NO
OF S
SEE
LAM
USE
UNL
INDI
WIR
INDI
CAL



FOR WIRING OF POWER SUPPLY TO LOAD REFER TO SUPPLY-TO-LOAD WIRING DIAGRAMS.

DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING CONNECTION.

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIXES B,C



SCHEMATIC DIAGRAM
ANALOG SECTION
REGULATED POWER SUPPLY
MODEL
LF-9-04

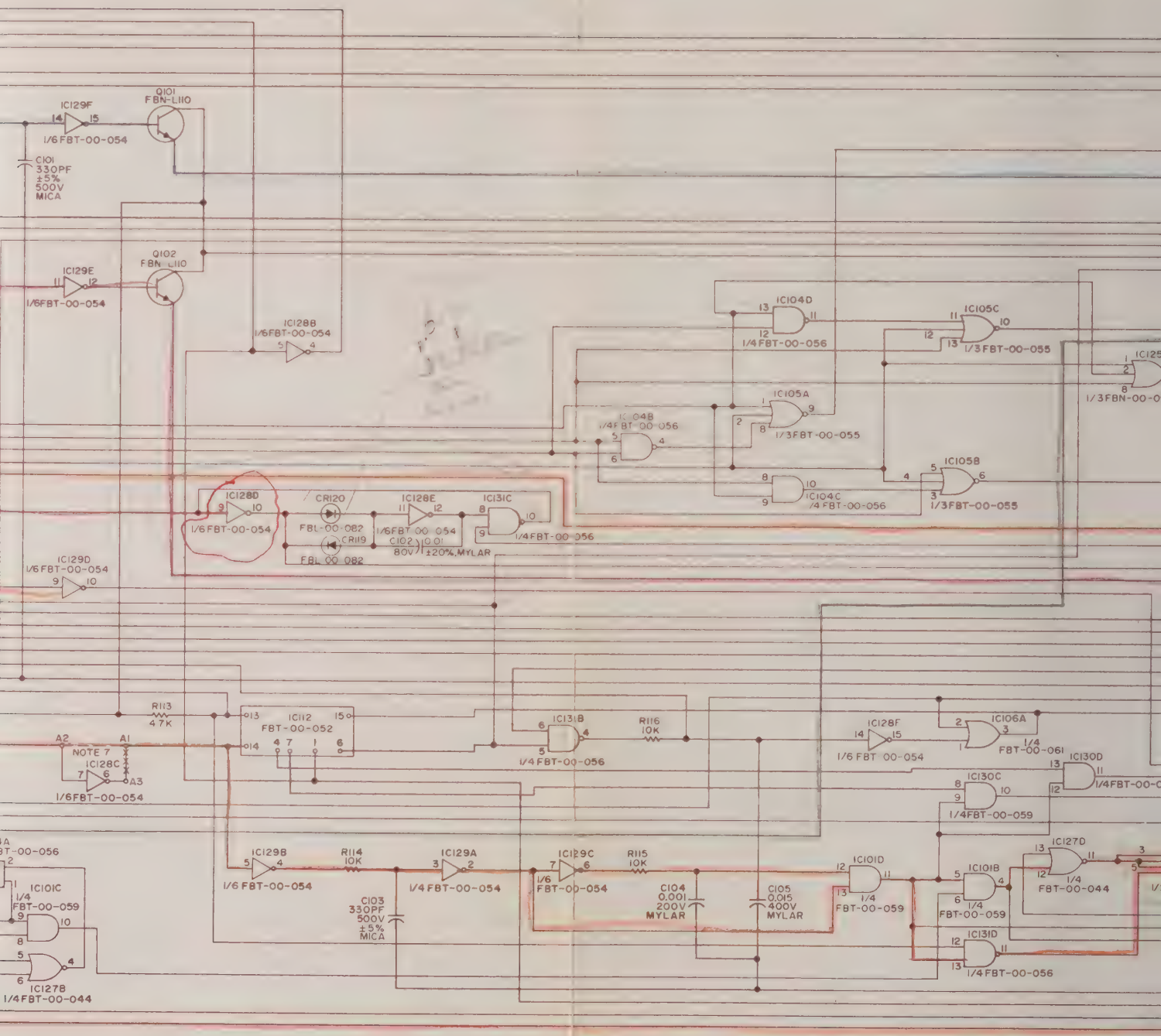
LAMBDA

ELECTRONICS
MELVILLE, NEW YORK

DIVISION OF Veeco INSTRUMENTS INC.

NOTES

1. RESISTORS ARE ±10%, 1/2
UNLESS OTHERWISE NOTED
2. CAPACITOR VALUES ARE IN
OTHERWISE NOTED.
3. CAPACITOR TOLERANCES
MYLAR ±10% UNLESS OTH
4. SYMBOLS
* SEE INSTRUCTION MANUA
-⊖- INDICATES TERMINAL ON
5. DESIGNATIONS ARE LAMBDA
6. CONDITIONS FOR CIRCUIT P
INPUT: 115VAC, 57-63Hz
OUTPUT PROGRAMMING- VO
CU
NO OUTPUT LOAD, S_1 AND V_{A1}
INDICATED VOLTAGES ARE D
DC MEASUREMENTS TAKEN
VOLTAGES ARE TAKEN BETW
(TERM B17) UNLESS OTHERW



OMP WITH VALUES IN OHMS

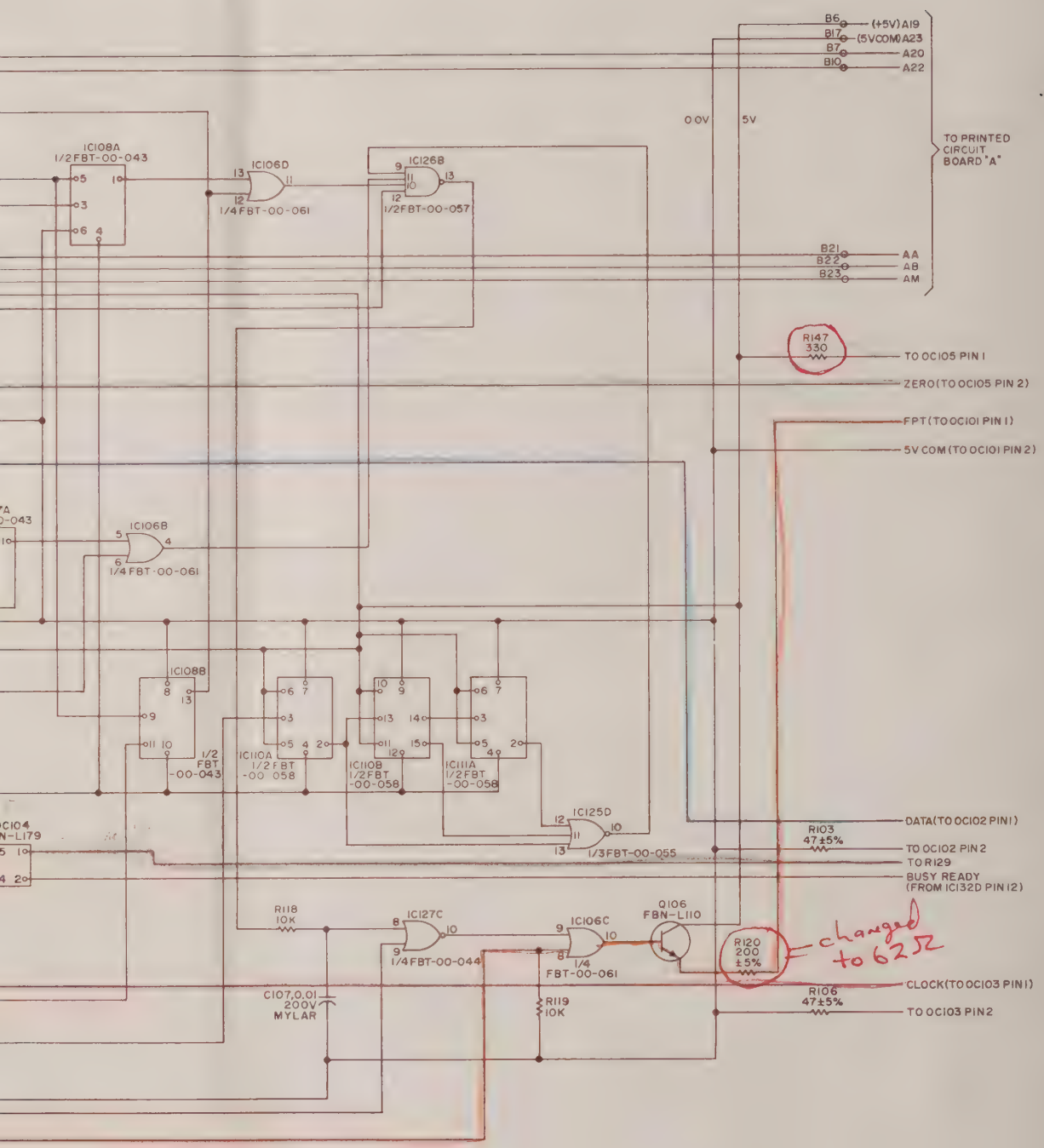
CROFARADS UNLESS

ECTROLYTIC -10+75%,
VISE NOTED.

NTED WIRING BOARD.
RT NUMBERS.
T MEASUREMENTS

AGE : +9.99V
NT : 99%
RTED, S2 AND V2 SHORTED.
LESS OTHERWISE NOTED.
H 20,000 OHMS/V VOLTMETER.
N INDICATED POINTS AND 5VCOM.
NOTED.

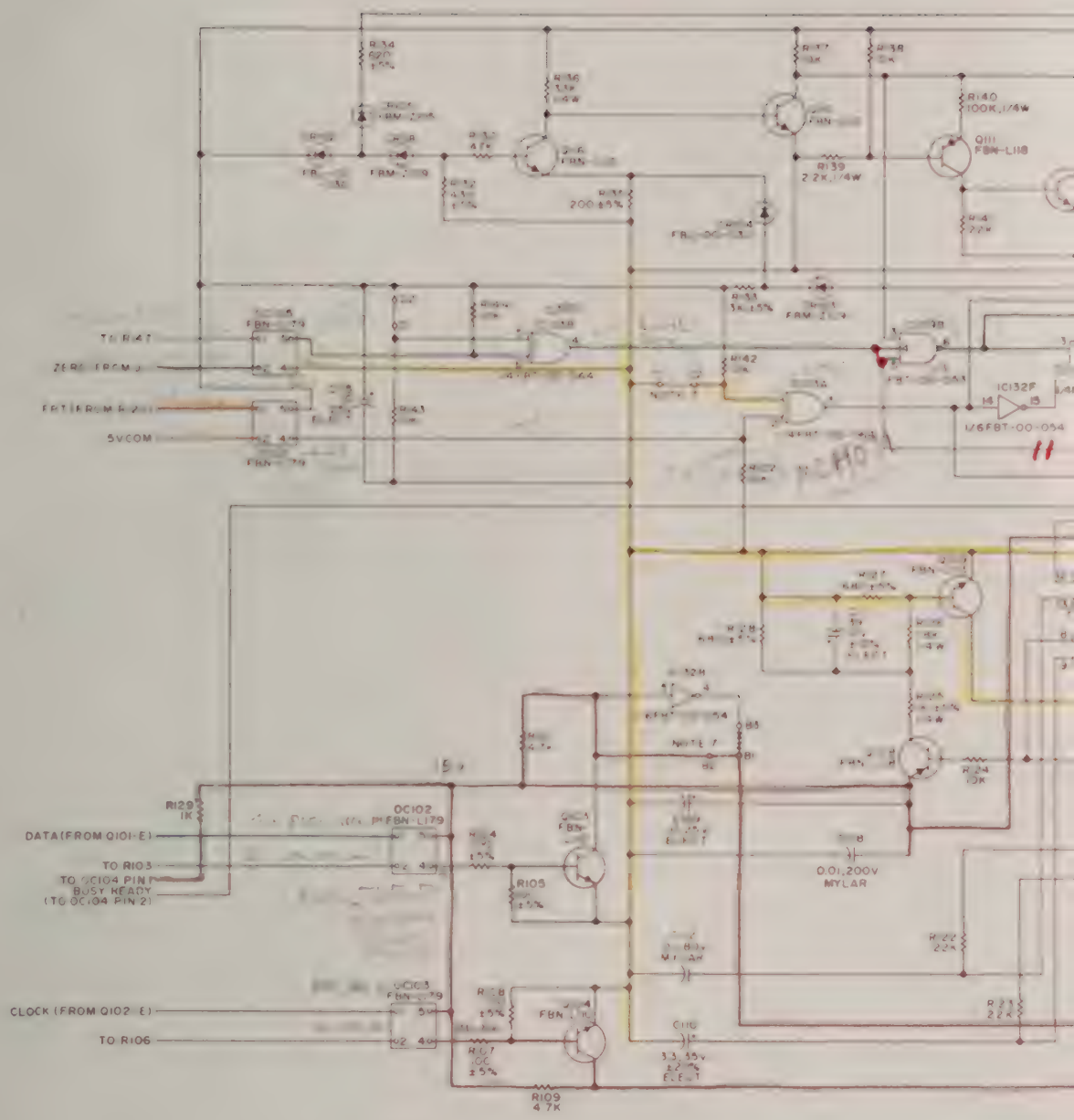
7. JUMPER BETWEEN TERM A1 AND A2 ON PRINTED CIRCUIT BOARD "B" FOR MODEL LF-9-04 WITH POSITIVE DATA INPUT LOGIC AND FOR MODEL LF-9-04-GPIB. JUMPER BETWEEN TERM A1 AND A3 ON PRINTED CIRCUIT BOARD "B" FOR MODEL LF-9-04 WITH NEGATIVE DATA INPUT LOGIC.
8. JUMPER BETWEEN TERMS E1 AND E2 ON PRINTED CIRCUIT BOARD "B" FOR MODEL LF-9-04. JUMPER BETWEEN TERMS E1 AND E3, F1 AND F2, H1 AND H2 ON PRINTED CIRCUIT BOARD "B" FOR MODEL LF-9-04-GPIB.
9. ON UNITS WITH "GPIB" OPTION: C106, IC114, IC115 ARE NOT USED.



SCHEMATIC DIAGRAM
DIGITAL INTERFACE SECTION
REGULATED POWER SUPPLY
MODEL
LF-9-04

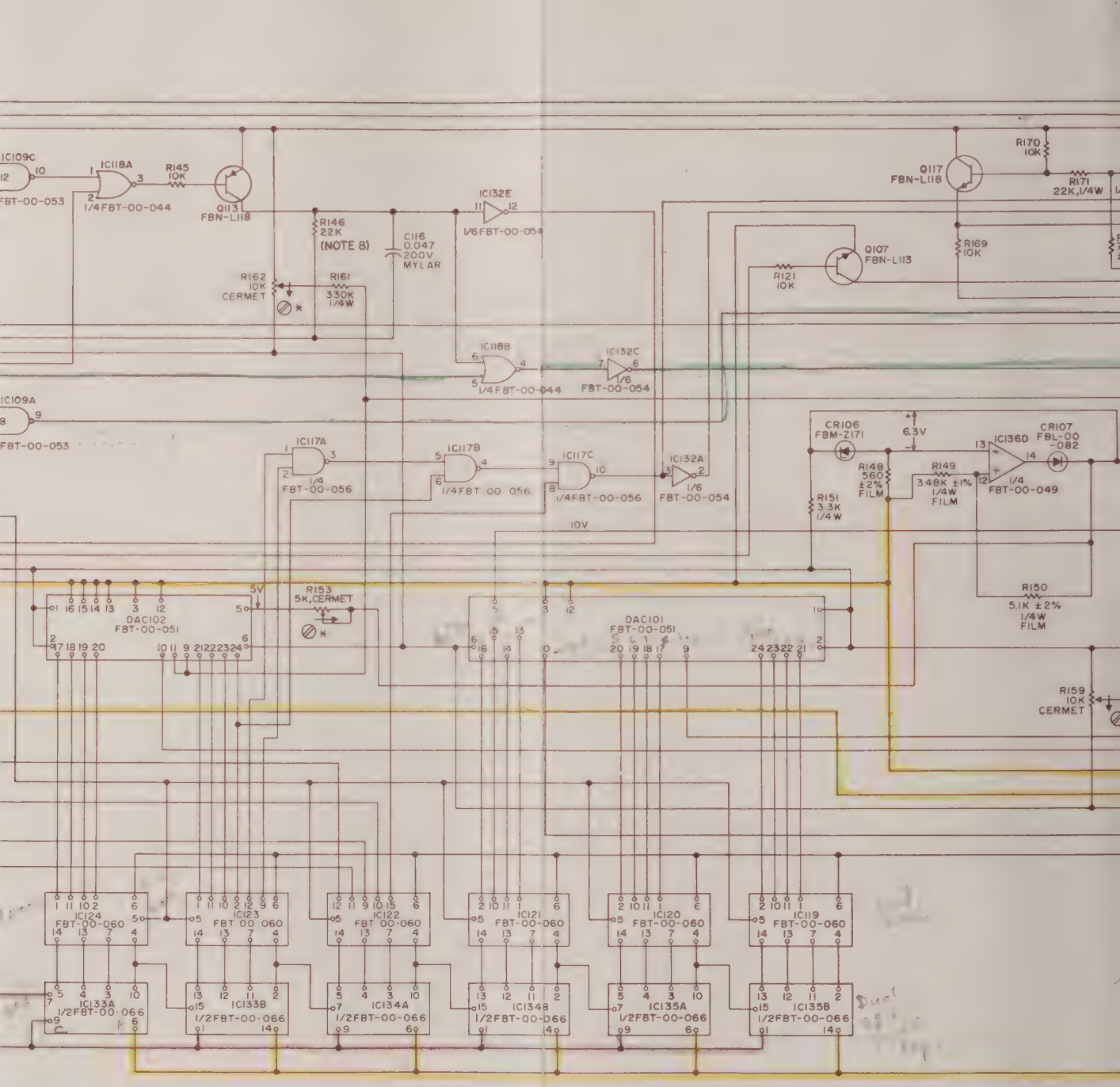
LAMBDA
ELECTRONICS
MELVILLE, NEW YORK
DIVISION OF Veeco INSTRUMENTS INC.

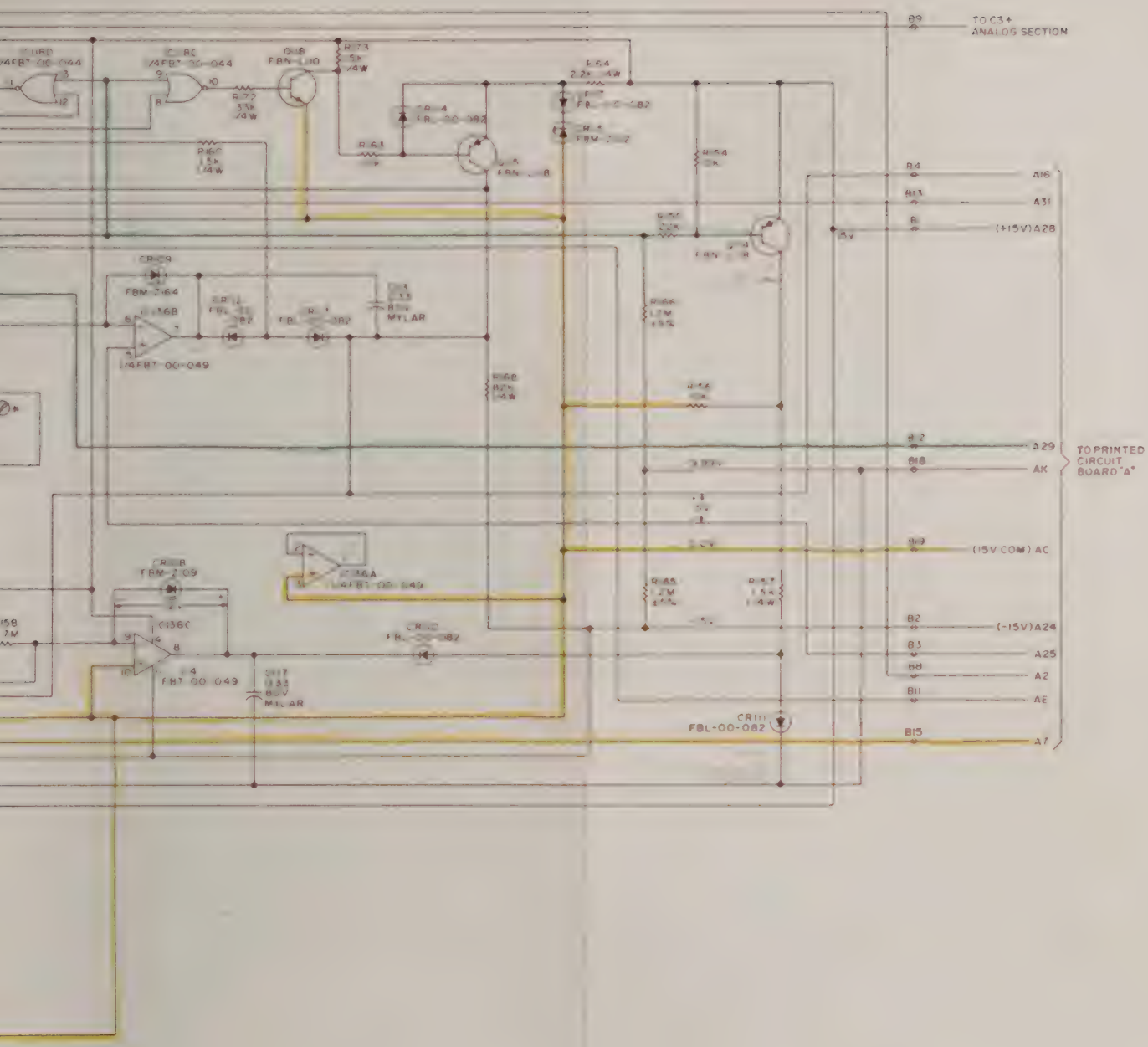
THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIXES B,C



NOTES

1. RESISTORS ARE ±10%, 1/2W COMP WITH VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED
3. CAPACITOR TOLERANCES ELECTROLYTIC −10 + 75%, MYLAR ±10% UNLESS OTHERWISE NOTED
4. SYMBOLS:
   - ↓ INDICATES CLOCKWISE ROTATION OF SHAFT.
   - ⊘ INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - * SEE INSTRUCTION MANUAL.
   - ⊖ INDICATES TERMINAL ON PRINTED WIRING BOARD.
5. DESIGNATIONS ARE LAMBDA PART NUMBERS.
6. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS:
   INPUT: 115 VAC, 57-63Hz
   OUTPUT PROGRAMMING - VOLTAGE: +9.99V
   CURRENT: 99%
   NO OUTPUT LOAD, S1 AND V1 SHORTED, S2 AND V2 SHORTED. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER. VOLTAGES ARE TAKEN BETWEEN INDICATED POINTS AND 15V COM (TERM B19) UNLESS OTHERWISE NOTED.
7. JUMPERS BETWEEN TERMINALS B1 AND B2, C1 AND C2 ON PRINTED CIRCUIT BOARD "B" FOR MODEL LF-9-04 WITH POSITIVE DATA INPUT LOGIC AND FOR MODEL LF-9-04-GPIB. JUMPER BETWEEN TERMINALS B1 AND B3 ON PRINTED CIRCUIT BOARD "B" FOR MODEL LF-9-04 WITH NEGATIVE DATA INPUT LOGIC
8. ON UNITS WITH "GPIB" OPTION, R146 IS


IC109C
FBT-00-053
IC118A
1/4FBT-00-044
R145
10K
Q113
FBN-L118
R146
22K
(NOTE 8)
C116
0.047
200V
MYLAR
IC132E
1/6FBT-00-054
R162
10K
CERMET
R161
330K
1/4W
IC118B
1/4FBT-00-044
IC132C
1/6
FBT-00-054
IC109A
FBT-00-053
IC117A
1/4
FBT-00-056
IC117B
1/4FBT 00 056
IC117C
1/4FBT-00-056
IC132A
1/6
FBT-00-054
10V
Q117
FBN-L118
R170
10K
R171
22K,1/4W
Q107
FBN-L113
R121
10K
R169
10K
CR106
FBM-Z171
6.3V
CR107
FBL-00
-082
IC136D
1/4
FBT-00-049
R148
560
±2%
FILM
R149
3.48K ±1%
1/4W
FILM
R151
3.3K
1/4W
R150
5.1K ±2%
1/4W
FILM
5V
R153
5K,CERMET
DAC102
FBT-00-051
DAC101
FBT-00-051
R159
10K
CERMET
IC124
FBT-00-060
IC123
FBT 00 060
IC122
FBT 00-060
IC121
FBT-00-060
IC120
FBT-00-060
IC119
FBT-00-060
IC133A
1/2FBT-00-066
IC133B
1/2FBT-00-066
IC134A
1/2FBT-00-066
IC134B
1/2FBT-00-066
IC135A
1/2FBT-00-066
IC135B
1/2FBT-00-066



SCHEMATIC DIAGRAM

DIGITAL STORAGE AND DIGITAL
TO ANALOG CONVERTER SECTIONS

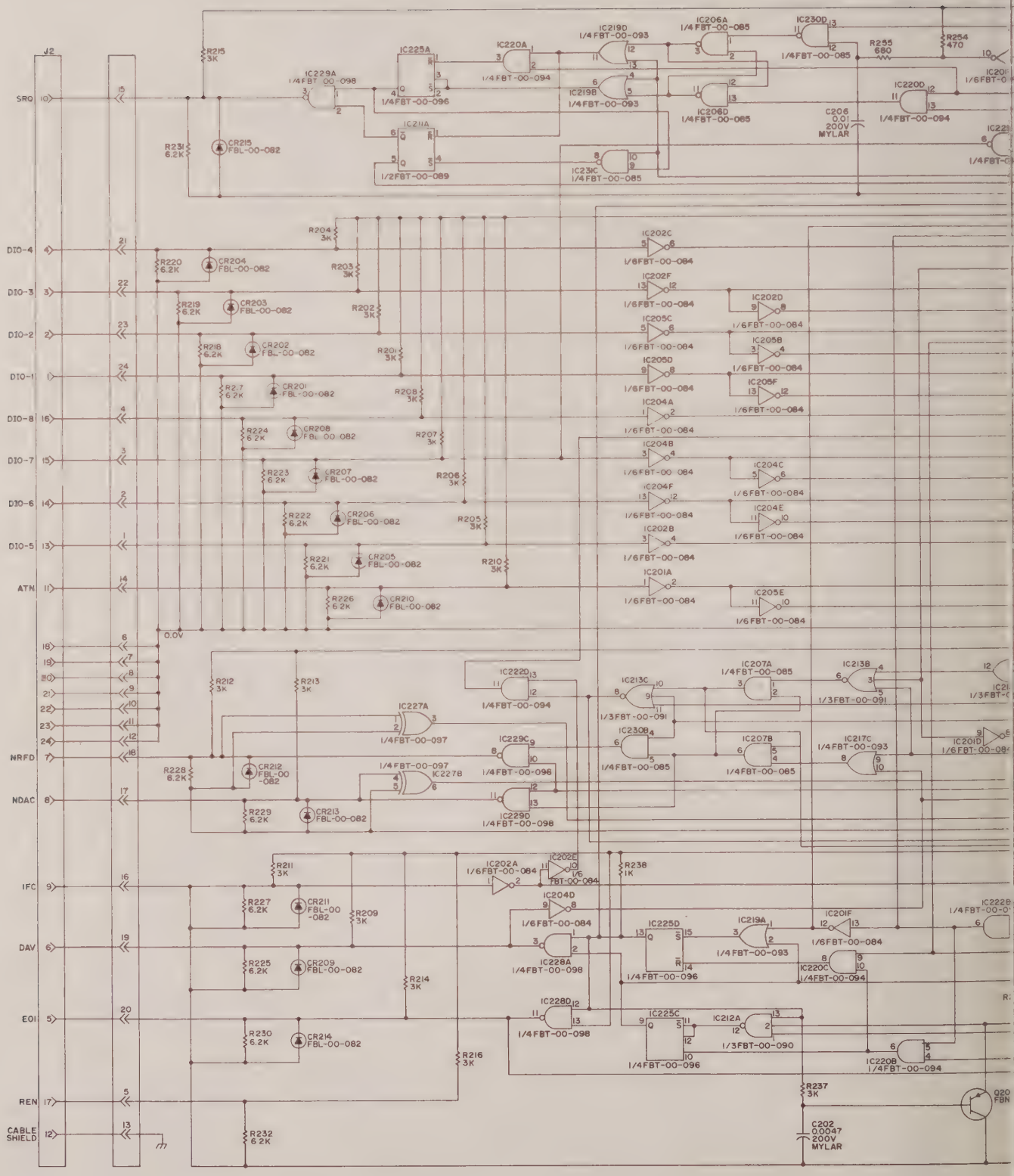
MODEL
LF-9-04

THIS SCHEMATIC APPLIES TO UNITS
BEARING SERIAL NO. PREFIXES B,C

LAMBDA

ELECTRONICS
MELVILLE, NEW YORK

DIVISION OF Veeco INSTRUMENTS INC.


J2
SRQ
DIO-4
DIO-3
DIO-2
DIO-1
DIO-8
DIO-7
DIO-6
DIO-5
ATN
NRFD
NDAC
IFC
DAV
EOI
REN
CABLE SHIELD
0.0V
R215 3K
R231 6.2K
CR215 FBL-00-082
IC229A 1/4FBT-00-098
IC225A
1/4FBT-00-096
IC211A
1/2FBT-00-089
IC220A
1/4FBT-00-094
IC219D 1/4FBT-00-093
IC219B 1/4FBT-00-093
IC206A 1/4FBT-00-085
IC206D 1/4FBT-00-085
IC230D
1/4FBT-00-085
IC223C 1/4FBT-00-085
R255 680
R254 470
C206 0.01 200V MYLAR
IC220D
1/4FBT-00-094
R204 3K
R203 3K
R202 3K
R201 3K
R208 3K
R207 3K
R206 3K
R205 3K
R210 3K
R220 6.2K
R219 6.2K
R218 6.2K
R217 6.2K
R224 6.2K
R223 6.2K
R222 6.2K
R221 6.2K
R226 6.2K
CR204 FBL-00-082
CR203 FBL-00-082
CR202 FBL-00-082
CR201 FBL-00-082
CR208 FBL-00-082
CR207 FBL-00-082
CR206 FBL-00-082
CR205 FBL-00-082
CR210 FBL-00-082
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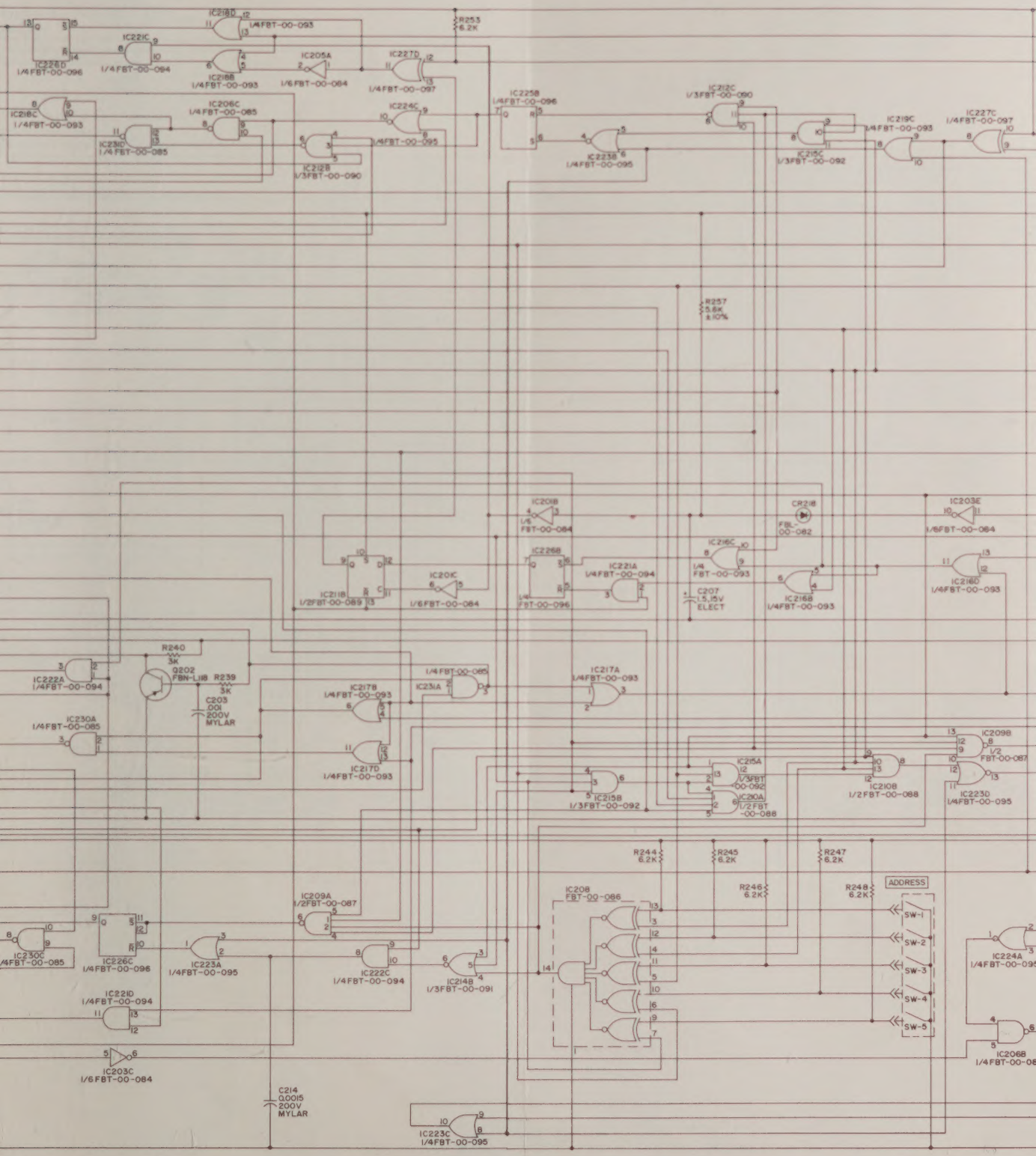
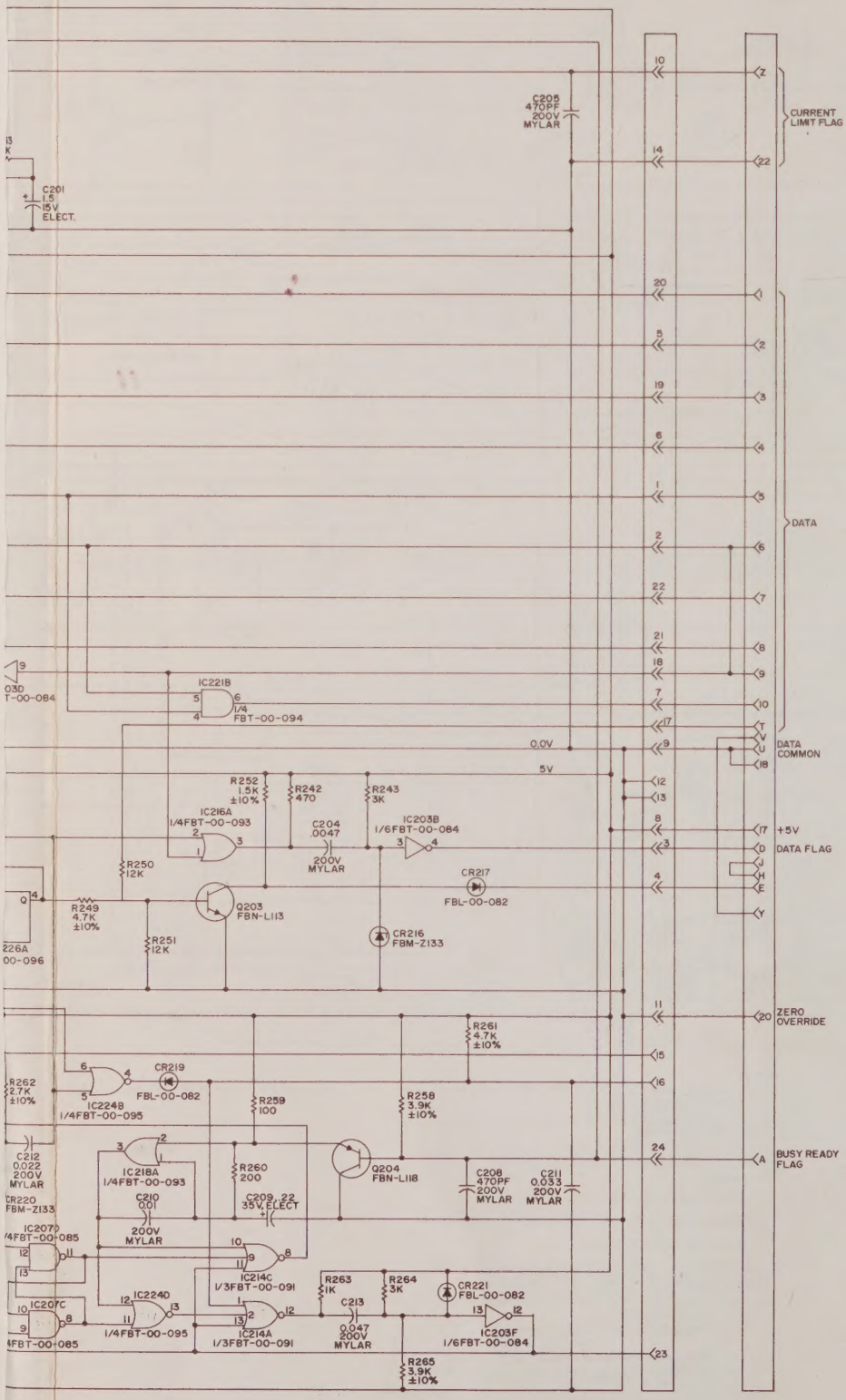
IC202F
IC205C
IC205D
IC204A
IC204B
IC204F
IC202B
IC201A
IC202D
IC205B
IC205F
IC204C
IC204E
IC205E
1/6FBT-00-084
R212 3K
R213 3K
R228 6.2K
R229 6.2K
CR212 FBL-00-082
CR213 FBL-00-082
IC227A
1/4FBT-00-097
IC227B
IC229C
IC229D
1/4FBT-00-098
IC222D
1/4FBT-00-094
IC213C
1/3FBT-00-091
IC230B
1/4FBT-00-085
IC207A
1/4FBT-00-085
IC207B
1/4FBT-00-085
IC213B
1/3FBT-00-091
IC217C
1/4FBT-00-093
R211 3K
R227 6.2K
R225 6.2K
R230 6.2K
CR211 FBL-00-082
CR209 FBL-00-082
CR214 FBL-00-082
R209 3K
R214 3K
R216 3K
R232 6.2K
IC202A
IC202E
IC204D
IC228A
1/4FBT-00-098
IC228D
1/4FBT-00-098
IC225D
IC225C
1/4FBT-00-096
IC219A
1/4FBT-00-093
IC220C
1/4FBT-00-094
IC212A
1/3FBT-00-090
IC220B
1/4FBT-00-094
R238 1K
R237 3K
C202 0.0047 200V MYLAR
Q20 FBN


IC226D 1/4FBT-00-096
IC221C 1/4FBT-00-094
IC216D 1/4FBT-00-093
IC216B 1/4FBT-00-093
IC205A 1/6FBT-00-084
IC227D 1/4FBT-00-097
R253 6.2K
IC218C 1/4FBT-00-093
IC231D 1/4FBT-00-085
IC206C 1/4FBT-00-085
IC212B 1/3FBT-00-090
IC224C 1/4FBT-00-095
IC225B 1/4FBT-00-096
IC223B 1/4FBT-00-095
IC212C 1/3FBT-00-090
IC215C 1/3FBT-00-092
IC219C 1/4FBT-00-093
IC227C 1/4FBT-00-097
R257 5.6K ±10%
IC201B 1/6 FBT-00-084
IC226B 1/4 FBT-00-096
IC221A 1/4FBT-00-094
IC216C 1/4 FBT-00-093
CR218 FBL-00-082
IC216B 1/4FBT-00-093
C207 15.15V ELECT
IC203E 1/6FBT-00-084
IC216D 1/4FBT-00-093
IC218 1/2FBT-00-089
IC201C 1/6FBT-00-084
R240 3K
Q202 FBN-L118
R239 3K
C203 .001 200V MYLAR
IC222A 1/4FBT-00-094
IC230A 1/4FBT-00-085
IC217B 1/4FBT-00-093
1/4FBT-00-085 IC231A
IC217A 1/4FBT-00-093
IC217D 1/4FBT-00-093
IC215B 1/3FBT-00-092
IC215A 1/3FBT 00-092
IC220A 1/2FBT -00-088
IC210B 1/2FBT-00-088
IC209B 1/2 FBT-00-087
IC223D 1/4FBT-00-095
R244 6.2K
R245 6.2K
R247 6.2K
R246 6.2K
R248 6.2K
IC208 FBT-00-086
ADDRESS
SW-1
SW-2
SW-3
SW-4
SW-5
IC209A 1/2FBT-00-087
IC230C 1/4FBT-00-085
IC226C 1/4FBT-00-096
IC223A 1/4FBT-00-095
IC222C 1/4FBT-00-094
IC214B 1/3FBT-00-091
IC224A 1/4FBT-00-095
IC221D 1/4FBT-00-094
IC203C 1/6FBT-00-084
IC206B 1/4FBT-00-08
C214 0.0015 200V MYLAR
IC223C 1/4FBT-00-095



NOTES:

1. RESISTORS ARE ±5%, 1/2W COMP WITH VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
3. CAPACITOR TOLERANCES:
   ELECTROLYTIC ±10%
   MYLAR ±10%
4. DESIGNATIONS ARE LAMBDA PART NUMBERS.
5. SYMBOL
   ▭ INDICATES ACTUAL UNIT MARKING
6. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS
   INPUT: 115VAC, 57-63Hz
   OUTPUT PROGRAMMING:
   VOLTAGE: +9.99V
   CURRENT: 99%
   NO OUTPUT LOAD, S_1 AND V_1 SHORTED, S_2 AND V_2 SHORTED. INDICATED VOLTAGES ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER. VOLTAGES ARE TAKEN BETWEEN INDICATED POINTS AND 5V COM (P1-PIN U) UNLESS OTHERWISE NOTED.

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIXES B,C

SCHEMATIC DIAGRAM
"GPIB" DECODER SECTION
REGULATED POWER SUPPLY
MODEL
LF-9-04-GPIB

LAMBDA
ELECTRONICS
MELVILLE, NEW YORK
DIVISION OF Veeco INSTRUMENTS INC.

5-Year Guarantee

We warrant each instrument manufactured by us, and sold by us or our authorized agents, to be free from defects in material and workmanship, and that it will perform within applicable specifications for a period of five years after original shipment. Our obligation under this guarantee is limited to repairing or replacing any instrument or part thereof, (except tubes and fuses) which shall, within five years after delivery to the original purchaser, be returned to us with transportation charges prepaid, prove after our examination to be thus defective.

We reserve the right to discontinue instruments without notice, and to make modifications in design at any time without incurring any obligation to make such modifications to instruments previously sold.

LAMBDA ELECTRONICS

515 BROAD HOLLOW ROAD • MELVILLE, L. I., NEW YORK • 516 MYRTLE 4-4200

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MP MASTER

MA28355